1.0 INTRODUCTION

The Tennessee Products Site (the "Site") consists of a former coke production facility, its associated uncontrolled coal tar disposal areas, and approximately 2.5 stream-miles of sediments in Chattanooga Creek. The site was placed on the National Priorities List (NPL) in January of 1994 based on an EPA study of Chattanooga Creek and on a health advisory issued by the Agency for Toxic Substances and Disease Registry (ATSDR) concerning contact with the coal tar deposits.

A baseline risk assessment (BRA) is required for all NPL sites. The objective of this BRA was to assess the potential risks to human health caused by hazardous substances releases. The results of this assessment will be used to:

- Help determine whether additional response action is necessary at the site;
- Help support the "no action" remedial alternative, where appropriate; and
- Document the magnitude of risk at the site and the primary causes of that risk.

1.1 ORGANIZATION OF BASELINE RISK ASSESSMENT REPORT

This BRA report follows the suggested outline for a baseline risk assessment report, Exhibit 9-1 in U.S. EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Interim Final* (RAGS) (EPA, 1989a). Below is a brief description of each section.

- Section 2.0 is the data evaluation. Environmental data are tabulated, showing the occurrence and distribution of chemicals in the various environmental media. From this list of organic and inorganic substances present at the site, the most significant in terms of toxicity, concentration, and frequency of occurrence are selected as chemicals of potential concern (COPCs).

- Section 3.0 is the exposure assessment. Potential exposure points and migration pathways are identified. Exposure point concentrations and exposure doses are calculated. Uncertainties associated with the exposure assessment are discussed.

- Section 4.0 is the toxicity assessment. EPA toxicity values for each of the COPCs are presented.

- Section 5.0 is the risk characterization. The results of the data evaluation, exposure assessment, and toxicity assessment are combined to calculate an estimate of the risks to human health posed by chemicals at the site.

- Section 6.0 is a summary of the major conclusions.

- Section 7.0 presents the Remediation Goal Options and Chemicals of Concern.

- Section 8.0 is the list of references used in the preparation of this report.

2.0 DATA EVALUATION

Data used in this risk assessment were obtained from three major sources: the "Chattanooga Creek Sediment Profile Study" conducted by EPA between April and August 1992 (EPA, 1992a); surface soil data collected for the Mead Corp. (ERM, 1995); and the RI field investigation performed by CDM Federal Programs Corporation (CDM Federal) in 1995 for the U.S. EPA and compiled in the *Draft Interim RI Report* (CDM Federal, 1996).

2.1 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The data quality objectives (DQOs) that were assigned to these projects were discussed in the RI report (CDM Federal, 1996). Data that were judged suitable for use in baseline risk assessments were summarized to show all inorganic and organic chemicals that were positively identified in at least one sample. Included in this group were unqualified results and results that were qualified with a "J" which means the chemical was present but the concentration was estimated. These values are listed as actual detected concentrations and, therefore, may have the effect of under- or over-estimating the actual concentration. Tentatively identified compounds (qualified with an "N") were included if there was reason to believe that they were present. For example, if a compound was positively identified in other locations, the tentative identification was considered sufficient. Organic results qualified with a "B" or an "X", indicating that the analyte was also detected in a blank at a similar concentration, were not included.

The Tennessee Products Site is large and complex (multiple sources of contamination). To represent the risks associated with each source area as accurately as possible, the data were segregated into seven groups: the Coke Plant Area, the Schwerman Trucking Site, the Chattanooga Creek Tar Deposit, the Chattanooga Creek Sediments and Groundwater, the Residential Areas / School Yard, the surface water in streams on the Coke Plant, and the sediment in streams on the Coke Plant. Section 3.0 of this report provides a description of these areas. Detailed descriptions of the site and the results of the field investigation may be found in the RI report (CDM Federal, 1996).

Data from these areas are summarized in the following appendices:

- **Appendix A** - Coke Plant Area,
- **Appendix B** - Schwerman Trucking Site,
- **Appendix C** - Chattanooga Creek Tar Deposit,
- **Appendix D** - Chattanooga Creek Sediments and Groundwater,
- **Appendix E** - Residential Areas / School Yard.
- **Appendix F** - Surface water (other than Chattanooga Creek),
- **Appendix G** - Sediment (other than Chattanooga Creek), and
- **Appendix K** - Northeast Tributary Area.

Table 1 in each appendix shows the background concentration levels (control), the range of detections above the sample quantitation limit (SQL), arithmetic means of positive detections above the SQL, the number of detections above the SQL, and the number of samples for each medium.

COPCs were selected from these lists of positively identified chemicals according to EPA guidance (EPA 1995a). Three criteria were used in this screening process:

(1). Inorganics whose maximum concentration did not exceed two times the average background concentration were excluded;

(2). Inorganics that are essential nutrients or are normal components of our diets were excluded. Calcium, magnesium, potassium, and sodium were excluded from consideration as COPCs because they are essential nutrients, with no known toxic effects at any relevant dosage level; and

(3). Inorganic and organic chemicals that were detected at concentrations lower than a cancer risk level of 1×10^{-6} or a Hazard Quotient (HQ) level of 0.1 as determined by EPA Region III using residential land use assumptions were excluded. EPA Region III has developed risk-based

concentrations for nearly 600 chemicals by combining toxicity values derived from Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), Office of Health and Environmental Assessment-Cincinnati (OHEA) and other EPA sources with "standard" exposure scenarios (EPA, 1996a).

The risk-based screening was applied to soil, groundwater, surface water, sediment, and air data. As a measure of conservatism, risk-based concentrations for soil and tap water were applied to sediment and surface water although exposure to these media is expected to be less than for soil and tap water. The constituents that remained are the COPCs. They are presented in the following tables:

- **Table 2-1** - Coke Plant Area,
- **Table 2-2** - PAHs in Air at Coke Plant Area and the Schwerman Trucking Site,
- **Table 2-3** - Schwerman Trucking Site,
- **Table 2-4** - Chattanooga Creek Tar Deposit,
- **Table 2-5** - Chattanooga Creek Sediments and Groundwater,
- **Table 2-6** - Residential Areas / School Yard,
- **Table 2-7** - Surface water (other than Chattanooga Creek),
- **Table 2-8** - Sediment (other than Chattanooga Creek), and
- **Table 2-9** - Northeast Tributary Area.

Note that the risk-based screen was not strictly applied. That is, in certain cases, a chemical was retained as a COPC even if the maximum detection did not exceed the screening criterion. For example, chrysene [a carcinogenic polycyclic aromatic hydrocarbon (cPAH)] was retained even though it was not found above the screening level when other cPAHs (i.e., benzo(a)pyrene, benzo(a)anthracene) were detected above the screening criteria. This was also done as a measure of conservatism and to avoid the exclusion of certain chemicals that are clearly present and that have similar toxic properties.

Table 2-1
Chemicals of Potential Concern
Coke Plant Area
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Surface Soil		Groundwater	
	Minimum	Maximum	Minimum	Maximum
Arsenic	4.5	98	5	30
Barium	-	-	29	3,800
Beryllium	-	-	1	7
Cadmium	0.11	6.3	-	-
Cobalt	-	-	1	700
Chromium	6.4	926	1	23
Copper	6.8	840	-	-
Nickel	-	-	8	130
Lead	10.4	510	3.4	33
Antimony	0.31	42	-	-
Thallium	1	1	-	-
Mercury	0.1	29	-	-
Aluminum	-	-	50	47,000
Manganese	47	3,210	18	77,000
Iron	3,000	83,800	100	160,000
Cyanide	0.7	77.5	10	860
1,3-Dichlorobenzene	-	-	2	15
1,4-Dichlorobenzene	-	-	1	110
1,2-Dichlorobenzene	-	-	1	41
Naphthalene	150	2,600,000	2	6,100
Acenaphthylene	46	350,000	10	64
Acenaphthene	47	180,000	2	320
Fluorene	54	820,000	1	370
Phenanthrene	150	2,900,000	2	490
Anthracene	75	540,000	4	140
Fluoranthene	88	2,200,000	1	330
Pyrene	110	1,200,000	6	250
Bis(2-ethylhexyl)phthalate	-	-	500	500
Benzo(a)anthracene	76	780,000	120	120
Chrysene	130	750,000	98	98
Benzo(b &/or k)fluoranthene	110	1,100,000	1	110
Benzo(a)pyrene	40	540,000	10	82
Indeno(1,2,3-cd)pyrene	170	210,000	10	49
Dibenzo(a,h)anthracene	60	76,000	-	-

COPC Chemical of Potential Concern
- Not a COPC for this medium
Units are: ug/kg for organic soil, ug/l for organic water, mg/kg for inorganic soil and ug/l for inorganic water.

Table 2-1
Chemicals of Potential Concern
Coke Plant Area
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Surface Soil		Groundwater	
	Minimum	Maximum	Minimum	Maximum
Benzo(ghi)perylene	140	170,000	10	56
Phenol	-	-	3	2,200
2,4-Dimethylphenol	68	1,200	10	2,000
2-Methylnaphthalene	190	360,000	2	1,100
Dibenzofuran	110	430,000	2	250
3-Nitroaniline	-	-	25	25
2-Methylphenol	-	-	2	1,100
(3-and/or 4-)Methylphenol	46	6,500	10	2,000
Carbazole	44	320,000	2	330
Aldrin	45	45	-	-
Alpha-BHC	85	490	0.0053	6.9
Beta-BHC	22	380	0.011	4.7
Gamma-BHC (Lindane)	-	-	0.027	0.2
Delta-BHC	-	-	0.02	2.8
PCB-1254	2,100	2,100	-	-
2,3,7,8-TCDD TEQ	0.016	0.03	-	-
Chloroform	-	-	2	540
1,2-Dichloroethane	-	-	220	220
1,1,1-Trichloroethane	-	-	92	92
Carbon tetrachloride	-	-	620	620
Trichloroethene	-	-	53	53
Benzene	3	8700	1	2,600
Tetrachloroethene	-	-	1	10,000
Toluene	-	-	2	170,000
Chlorobenzene	-	-	2	1,100
Ethylbenzene	-	-	3	320
Acetone	-	-	83	1,700

COPC Chemical of Potential Concern
- Not a COPC for this medium
Units are: ug/kg for organic soil, ug/l for organic water, mg/kg for inorganic soil and ug/l for inorganic water.

Table 2-2
Polycyclic Aromatic Hydrocarbons of Potential Concern in Air
Coke Plant Area and Schwerman Trucking Site
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Coke Plant Area		Schwerman Trucking Site	
	Minimum	Maximum	Minimum	Maximum
Benzo(a)anthracene	0.001	0.002	0.001	0.001
Chrysene	0.001	0.001	0.001	0.001
Benzo(b)fluoranthene	0.002	0.004	0.002	0.002
Benzo(k)fluoranthene	0.001	0.001	0.001	0.001
Benzo(b &/or k)fluoranthene	0.003	0.004	0.003	0.003
Benzo(e)pyrene	0.001	0.001	0.001	0.001
Benzo(a)pyrene	0.001	0.001	-	-
Benzo(a&e)pyrene	0.002	0.003	0.001	0.001
Indeno(1,2,3-cd)pyrene	0.001	0.001	-	-

Footnotes:

Minimum / maximum detected concentration above the sample quantitation limit.

Units are ug/m3

- Not a COPC for this location

Table 2-3
Chemicals of Potential Concern
Schwerman Trucking Site
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Surface Soil		Groundwater	
	Minimum	Maximum	Minimum	Maximum
Arsenic	-	-	9	30
Beryllium	-	-	4	4
Cadmium	-	-	1	14
Chromium	-	-	3	23
Nickel	310	570	5	47,000
Vanadium	-	-	1	67
Aluminum	-	-	51	38,000
Manganese	-	-	320	15,000
Iron	-	-	8,800	460,000
Acetone	-	-	2,200	2,200
Methyl ethyl ketone	-	-	1,800	1,800
Methyl butyl ketone	-	-	290	290

Footnotes:

Minimum / maximum detected concentration above the sample quantitation limit.

Units are: ug/kg for organic soil, ug/l for organic water, mg/kg for inorganic soil and ug/l for inorganic water.

- Not a COPC for this location

Table 2-4
Chemicals of Potential Concern
Chattanooga Creek Tar Deposit
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Surface Soil		Groundwater	
	Minimum	Maximum	Minimum	Maximum
Arsenic	4	14	-	-
Chromium	19	140	-	-
Nickel	14	180	-	-
Benzo(a)anthracene	140	4,900	-	-
Benzo(b &/or k)fluoranthene	230	10,000	-	-
Benzo(a)pyrene	220	4,400	-	-
Indeno(1,2,3-cd)pyrene	240	3,500	-	-
Dibenzo(a,h)anthracene	670	900	-	-
Dieldrin	220	880	-	-

Footnotes:

Minimum / maximum detected concentration above the sample quantitation limit.

Units are ug/kg for organic results and mg/kg for inorganics.

- Not a COPC for this location

Table 2-5
Chemicals of Potential Concern
Chattanooga Creek Sediments and Groundwater
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Upper Reach (1)		Middle Reach (2)		Middle Reach Groundwater (3)		Lower Reach (4)	
1,4-Dichlorobenzene	-	-	-	-	1	1	-	-
1,2,4-Trichlorobenzene	-	-	110,000	110,000	-	-	-	-
Naphthalene	-	-	64	5,500,000	-	-	-	-
Acenaphthylene	-	-	48	370,000	-	-	-	-
Acenaphthene	-	-	53	2,400,000	-	-	-	-
Fluorene	-	-	70	2,900,000	-	-	-	-
Hexachlorobenzene	-	-	410	9,400	-	-	-	-
Phenanthrene	-	-	100	2,900,000	-	-	-	-
Anthracene	-	-	140	2,800,000	-	-	-	-
Fluoranthene	-	-	80	7,500,000	-	-	-	-
Pyrene	-	-	75	5,300,000	-	-	-	-
Benzo(a)anthracene	-	-	70	2,700,000	-	-	590	5,700
Chrysene	-	-	72	2,400,000	-	-	63	6,100
Benzo(b &/or k)fluoranthene	140	1,200	110	4,200,000	-	-	65	11,000
Benzo(a)pyrene	85	590	51	2,100,000	-	-	1,100	6,200
Indeno(1,2,3-cd)pyrene	52	460	42	1,900,000	-	-	450	6,100
Dibenzo(a,h)anthracene	76	100	51	410,000	-	-	81	1,400
Benzo(ghi)perylene	-	-	66	1,700,000	-	-	-	-
2-Methylnaphthalene	-	-	55	2,800,000	-	-	-	-
Dibenzofuran	-	-	41	1,900,000	-	-	-	-
Carbazole	-	-	82	860,000	-	-	-	-

Footnotes:

(1) The Upper reach is the area from Burnt Mill Bridge to the railroad bridge between Hooker and Hamill Roads.
(2) The Middle reach is the area between the railroad bridge (between Hooker and Hamill Roads) and Dobbs Branch.
(3) Groundwater from two monitor wells adjacent to Chattanooga Creek in the Middle reach of the creek.
(4) The Lower reach is the area between Dobbs Branch and the Tennessee River.

Minimum / maximum detected concentration above the sample quantitation limit.
Units are ug/kg for organic sediments, mg/kg for inorganic sediments, and ug/l for organic and inorganic groundwater.
- Not a COPC for this location
2,3,7,8-TCDD (tetrachloro-p-dibenzo dioxin)
TEQ Toxic Equivalency

Table 2-5
Chemicals of Potential Concern
Chattanooga Creek Sediments and Groundwater
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Upper Reach (1)		Middle Reach (2)		Middle Reach Groundwater (3)		Lower Reach (4)	
Alpha-BHC	-	-	11	51,000	0.1	0.1	-	-
Beta-BHC	-	-	-	-	0.069	0.11	-	-
Gamma-BHC (Lindane)	-	-	-	-	0.02	0.02	-	-
Delta-BHC	-	-	-	-	0.026	0.026	-	-
Dieldrin	-	-	100	7,100	0.015	0.015	-	-
DDT	-	-	40	2,900	-	-	-	-
PCB-1254	-	-	360	600	-	-	-	-
PCB-1248	-	-	12,000	12,000	-	-	-	-
PCB-1260	-	-	68	3,200	-	-	83	360
Gamma-chlordane	-	-	99	2,100	-	-	-	-
Aluminum	2,500	17,000	2,200	25,000	-	-	8,400	22,000
Antimony	-	-	-	-	-	-	23	23
Arsenic	2.6	11	3.8	40	-	-	5.4	11
Beryllium	-	-	1.6	2.6	-	-	-	-
Cadmium	-	-	-	-	-	-	2.5	5.3
Chromium	9	120	19	280	-	-	25	160
Iron	8,000	31,000	3,100	46,000	32,000	36,000	20,000	35,000
Lead	13	68	10	230	-	-	90	430
Manganese	210	1,100	28	1,700	-	-	430	2,800
Mercury	-	-	0.17	2.0	-	-	0.16	2.5
Carbon tetrachloride	-	-	16	380,000	-	-	-	-
Benzene	-	-	4,100	74,000	54	54	-	-
Chlorobenzene	-	-	10	270,000	520	810	-	-
2,3,7,8-TCDD TEQ	-	-	0.0045	0.13	-	-	-	-

Footnotes:

(1) The Upper reach is the area from Burnt Mill Bridge to the railroad bridge between Hooker and Hamill Roads.
(2) The Middle reach is the area between the railroad bridge (between Hooker and Hamill Roads) and Dobbs Branch.
(3) Groundwater from two monitor wells adjacent to Chattanooga Creek in the Middle reach of the creek.
(4) The Lower reach is the area between Dobbs Branch and the Tennessee River.

Minimum / maximum detected concentration above the sample quantitation limit.
Units are ug/kg for organic sediments, mg/kg for inorganic sediments, and ug/l for organic and inorganic groundwater.
- Not a COPC for this location
2,3,7,8-TCDD (tetrachloro-p-dibenzo dioxin)
TEQ Toxic Equivalency

Table 2-6
Chemicals of Potential Concern
Residential Areas/School Yard
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Surface Soil	
	Minimum	Maximum
Arsenic	3	15
Chromium	4	55
Antimony	2	4
Aluminum	2,100	32,000
Manganese	130	2,800
Benzo(a)anthracene	130	6,100
Chrysene	110	5,800
Benzo(b &/or k)fluoranthene	260	9,000
Benzo(a)pyrene	150	5,000
Indeno(1,2,3-cd)	280	2,300
Dibenzo(ah)anthracene	300	490
Heptachlor epoxide	89	89
Dieldrin	3	1,800
PCB-1254	160	160

Footnotes:

Minimum / maximum detected concentration above the sample quantitation limit.

Units are ug/kg for organic results and mg/kg for inorganics.

Table 2-7
Chemicals of Potential Concern
Surface Water (other than Chattanooga Creek)
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Coke Plant Area		Northeast Tributary		Northwest Tributary	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Arsenic	8	100	25	32	-	-
Barium	34	360	29	540	-	-
Beryllium	-	-	1	1	-	-
Chromium	14	180	-	-	-	-
Copper	370	370	25	320	-	-
Lead	3	440	2	180	-	-
Vanadium	56	56	3	48	-	-
Zinc	-	-	150	2,500	-	-
Aluminum	5,000	23,000	570	27,000	-	-
Manganese	540	7,000	650	8,600	400	940
Iron	680	66,000	780	47,000	440	1,700
Cyanide	12	350	13	480	-	-
1,4-Dichlorobenzene	-	-	1	11	-	-
Naphthalene	-	-	3	1,600	-	-
Acenaphthylene	3	3	1	30	-	-
Acenaphthene	-	-	23	260	-	-
Fluorene	2	2	23	200	-	-
Phenanthrene	9	9	1	190	-	-
Anthracene	4	4	5	31	-	-
Fluoranthene	-	-	1	68	-	-
Pyrene	-	-	1	50	-	-
Benzo(a)anthracene	4	4	3	15	-	-
Chrysene	-	-	2	12	-	-
Benzo(b &/or k)-fluoranthene	7	7	2	22	-	-
Benzo(a)pyrene	-	-	1	8	-	-
Indeno(1,2,3-cd) pyrene	6	6	3	6	-	-
Dibenzo(a,h)-anthracene	-	-	2	2	-	-
2,4-Dimethlylphenol	-	-	17	260	-	-
2-Methylphenol	-	-	14	390	-	-
3 and/or 4-Methyl-phenol	-	-	6	490	-	-
Carbazole	-	-	35	500	-	-
Alpha-BHC	-	-	0.1	2.8	-	-
Beta-BHC	-	-	0.1	1.1	-	-
Gamma-BHC	-	-	0.3	0.3	-	-
Delta-BHC	-	-	0.1	0.1	-	-
Chloroform	-	-	-	-	3	3
Trichloroethene	-	-	4	9	-	-
Benzene	-	-	2	1,700	-	-
Tetrachloroethene	-	-	4	4	-	-
Chlorobenzene	-	-	10	420	-	-
1,2-Dichloroethene (total)	-	-	7	38	-	-

COPC Chemical of Potential Concern
- Not a COPC for this medium
Units are ug/l

Table 2-8
Chemicals of Potential Concern
Sediment (other than Chattanooga Creek)
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Coke Plant Area		Northeast Tributary		Northwest Tributary	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Arsenic	16	77	6	21	9	22
Beryllium	2.4	2.4	-	-	-	-
Cadmium	-	-	3	6	6	6
Chromium	38	920	18	69	-	-
Copper	-	-	24	9,500	47	470
Lead	68	450	-	-	-	-
Mercury	0.9	5.5	-	-	-	-
Aluminum	5,000	13,000	3,100	21,000	-	-
Manganese	780	990	370	4,300	1,200	24,000
Iron	27,000	35,000	18,000	60,000	28,000	71,000
Cyanide	4	88	1	89	-	-
Naphthalene	3,000	1,700,000	-	-	-	-
Phenanthrene	1,800	470,000	460	310,000	-	-
Fluoranthene	1,900	440,000	130	720,000	-	-
Pyrene	-	-	100	800,000	-	-
Benzo(a)anthracene	2,000	2,000	8,600	560,000	860	860
Chrysene	2,100	140,000	460	460,000	-	-
Benzo(b &/or k) fluoranthene	1,600	170,000	200	340,000	900	1,000
Benzo(a)pyrene	1,500	97,000	460	370,000	800	1,000
Indeno(1,2,3-cd) pyrene	1,200	53,000	1,100	220,000	580	630
Dibenzo(a,h)anthracene	-	-	2,700	42,000	-	-
4-Chloro-3-methylphenol	-	-	31,000	31,000	-	-
Dibenzofuran	550	100,000	-	-	-	-
Alpha-BHC	100	100	3	2,300	-	-
Beta-BHC	-	-	3	590	-	-

COPC Chemical of Potential Concern
- Not a COPC for this medium
Units are: ug/kg for organics, mg/kg for inorganics

Table 2-9
Chemicals of Potential Concern in Soil
Northeast Tributary Area
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Surface Soil	
	Minimum	Maximum
Arsenic	3.4	29
Chromium	18	80
Lead	31	780
Antimony	20	20
Thallium	4.2	4.2
Mercury	0.4	11
Cyanide	3.7	260
Naphthalene	1,400	190,000
Acenaphthylene	12,000	97,000
Acenaphthene	6,600	94,000
Fluorene	1,900	160,000
Phenanthrene	4,000	1,900,000
Anthracene	6,200	210,000
Fluoranthene	22,000	1,900,000
Pyrene	26,000	2,000,000
Benzo(a)anthracene	24,000	840,000
Chrysene	24,000	840,000
Benzo(b &/or k)	45,000	1,800,000
Benzo(a)pyrene	25,000	1,000,000
Indeno(1,2,3-cd)	15,000	470,000
Dibenzo(ah)anthracene	96,000	96,000
Benzo(ghi)perylene	15,000	500,000
Dibenzofuran	550	150,000
Carbazole	1,100	96,000
Alpha-BHC	370	4,800
Dieldrin	120	120
4,4-DDE (p,p-DDE)	13,000	13,000
Methoxychlor	3,100	78,000

Footnotes:

Minimum / maximum detected concentration above the sample quantitation limit.

Units are ug/kg for organic results and mg/kg for inorganics.

3.0 EXPOSURE ASSESSMENT

Exposure pathways are determined in a conceptual site model that incorporates information on the potential chemical sources, affected media, release mechanisms, potential exposure pathways, and known receptors to identify complete exposure pathways. A pathway is considered complete if (1) there is a source or chemical release from a source; (2) there is an exposure point where contact can occur; and (3) there is a route of exposure (oral, dermal, or inhalation) through which the chemical may be taken into the body.

3.1 EXPOSURE SETTING

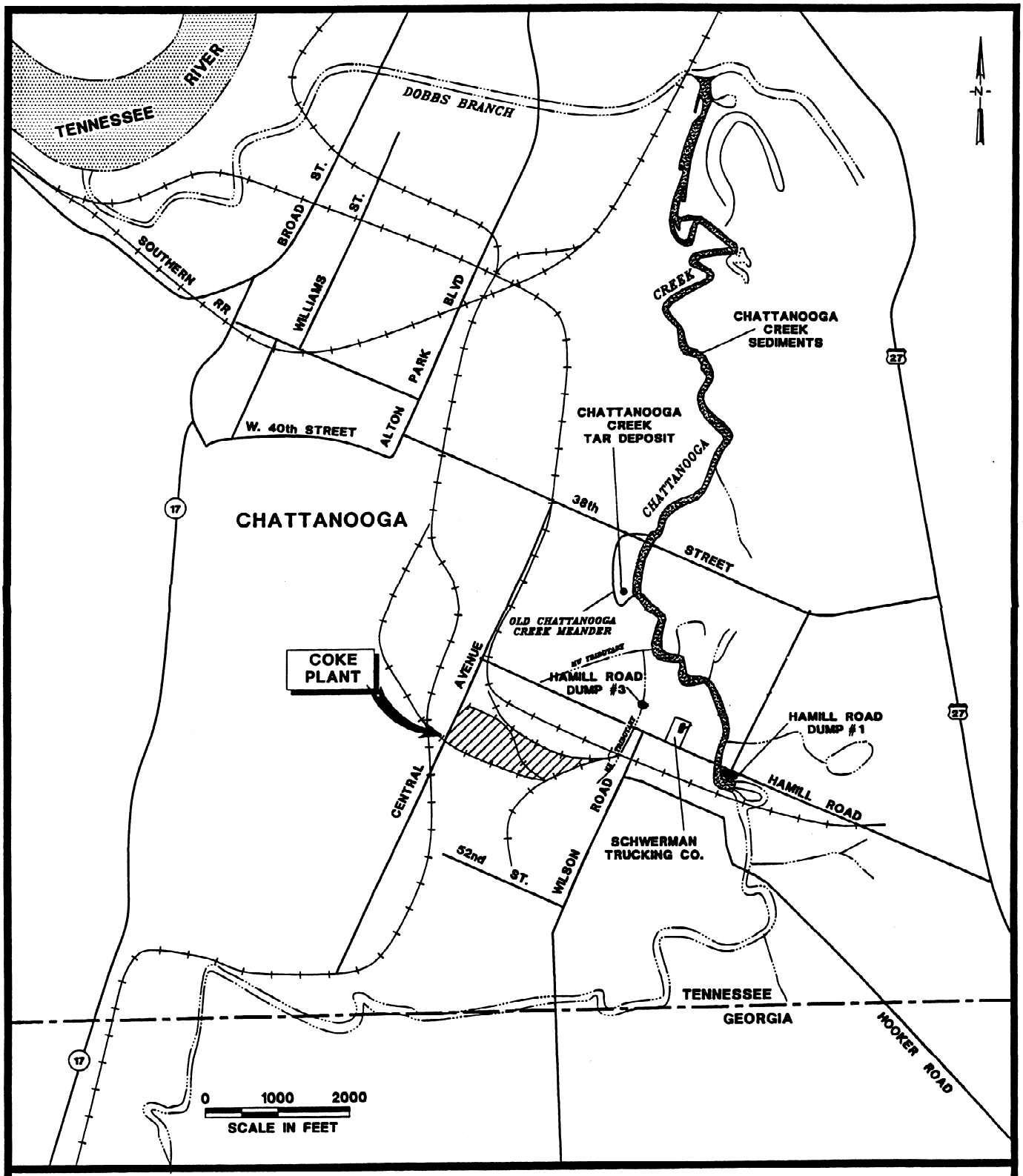
3.1.1 SITE DESCRIPTION

The site is located in an urban industrial and residential area of south Chattanooga in Hamilton County, Tennessee. It consists of three distinct source areas of contamination: a former coke production plant (Coke Plant), its associated uncontrolled waste disposal areas which currently include Schwerman Trucking Site and the Chattanooga Creek Tar Deposit, and approximately 2.5 stream-miles of Chattanooga Creek sediments. The locations of these source areas with approximate site boundaries are shown in **Figure 3-1**. Brief descriptions are provided below.

3.1.1.1 Coke Plant

The Coke Plant is situated in a low lying area bordering the Chattanooga Creek floodplain. Relief across the essentially flat site is less than 26 feet and the general slope is to the east. The facility occupies 24 acres.

All railroad tracks and above ground structures have been removed. The only existing structures are an underground storage tank (UST) of unknown size, several manholes, underground conduits, and pipelines, the API oil/water separator located at the east end of the site, and the building foundations.



REGIONAL SITE MAP

CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 3-1

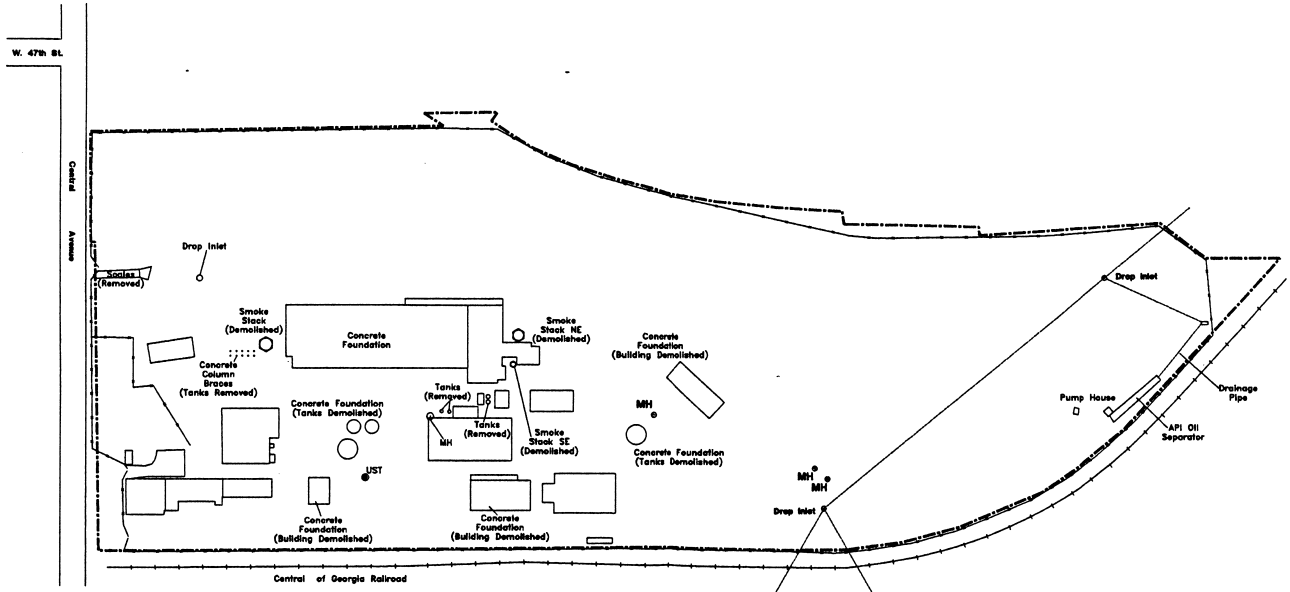
regloc/5may95/1=1

Most of the large piles of coal and coke have also been removed, but there are still two piles located in the eastern portion of the site and one pile located in the northwestern corner of the site which are overgrown with vegetation (see **Figure 3-2**). In addition, a layer of coke breeze (coke particles less than one-half inch in diameter) covers the majority of the site. The coke breeze (generally from 2 to 5 feet thick) also extends off-site to the north. The facility is completely surrounded by a security fence with warning signs posted. The eastern half of the site is overgrown with low-level vegetation but is readily accessible to trespassers.

Runoff from the coke plant facility takes one of three courses: the sewer system, the Northwest Tributary, or the Northeast Tributary (see Figure 3-1). All three of these courses lead to Chattanooga Creek. Most of the facility runoff is directed toward the API separator, which empties into the sewer system that discharges into the Northeast Tributary in the middle of the Landes Company Site. However, when the separator overflows, runoff is directed toward the Northeast Tributary via a ditch located along the eastern property boundary (on the north side of the railroad tracks). Some of the runoff from the northwestern part of the facility is directed to the Northwest Tributary via underground culverts. A spring located in the northwestern part of the facility (along the northern boundary) also discharges into the Northwest Tributary.

3.1.1.2 Schwerman Trucking Site

The Schwerman Trucking Site is a small area (less than ¼ acre) located in the floodplain of Chattanooga Creek on the Schwerman Trucking Company property. (The State of Tennessee previously defined Schwerman Trucking Site as one of the large tar deposits found in the stream bed of Chattanooga Creek. For the purpose of this risk assessment, however, EPA redefined Schwerman Trucking Site to be the waste piles in the Chattanooga Creek floodplain on the Schwerman Trucking Company property, and considers the tar deposits found in the stream bed of Chattanooga Creek to be part of the Chattanooga Creek Sediments source area). A site map is shown in **Figure 3-3**.



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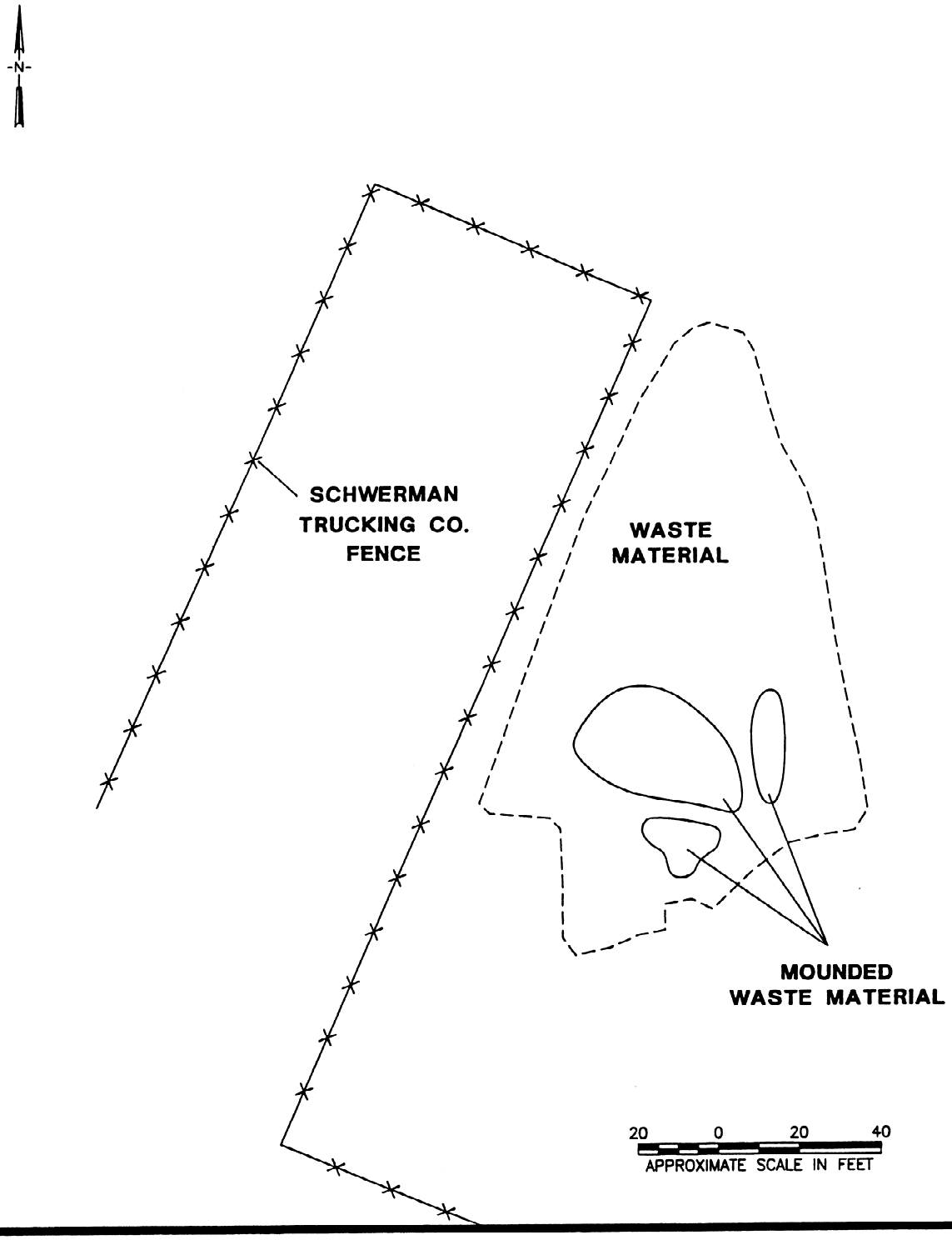
COKE PLANT CURRENT SITE MAP
Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 3-2

CHATT/1/1/056/2



SCHWERMAN TRUCKING SITE MAP

CDM FEDERAL PROGRAMS CORPORATION
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Tennessee Products Site
Chattanooga, Tennessee

FIGURE No. 3-3

dump2/8JUL96/160

The primary physical features of Schwerman Trucking Site are the three mounds of waste material (a dried black sludge) which have a total area of approximately 2,400 square feet and height of approximately 2 feet. The depth of the waste material is unknown. Although a security fence has been installed along the western and southern sides of the dump to separate it from the Schwerman Trucking Company operations, no guard or security fencing presently exists on the northern or eastern sides of the dump.

3.1.1.3 Chattanooga Creek Tar Deposit

The Chattanooga Creek Tar Deposit is located in the floodplain of the Chattanooga Creek. It is located west of the present creek channel between Hamill Road and 38th Street in or near an old creek meander, in a wooded area (see Figure 3-1). It is triangular in shape and covers an area of approximately 1,250 square feet. Its depth is unknown, but probing indicates that it exceeds three feet. The deposit is level and covered by a thin layer of soil and dried mud, which, when undisturbed, disguises the tar and gives the area a deceptively "normal" appearance; in reality, it is very unstable. Although an access road to the bank of Chattanooga Creek is located approximately 100 feet to the south, the deposit is presently surrounded by a security fence to minimize or prevent access.

3.1.1.4 Chattanooga Creek Sediments

Chattanooga Creek originates in Georgia where it flows mainly through undeveloped areas. However, in Tennessee, Chattanooga Creek flows through several industrial areas and urban developments. The creek bed is barricaded by numerous fallen trees and sewage pipes. These natural and artificial barriers impede creek flow and thus collect household litter in their upstream pools throughout the length of the stream. Oily sheens on top of the water have been noted in these areas. In addition, iron bacteria growths resembling oily sheens have been observed along the creek. This bacteria grows abundantly in low-oxygen, non-iron bearing waters. Heavy debris including unidentified metal structures, industrial containers, tires, drums, cars, and animal carcasses have also been observed in the creek bed and along both banks of the stream.

Two distinct types of coal tar accumulations have been identified in Chattanooga Creek. One type of deposit exists as extensive reaches of sediments that are heavily contaminated (saturated) with coal tar. These deposits are present for at least 11,900 feet of the stream bed from a point designated 1,700 feet upstream (south) of the intersection of the creek and 38th Street Bridge to the point of the creek's confluence with the Dobbs Branch section of the creek. The second type of coal tar deposit exists primarily as large quantity mounds of coal tar waste in the creek bed. These deposits are located in an area marked by the intersection of the creek and Hamill Road Bridge to a point of overlap with the above deposits approximately 1,800 feet downstream (north) of this intersection. Several large distinct shoals of coal tar waste are located in this reach of the creek bed. The approximate locations of these shoals are indicated in **Figure 3-4**. They are covered by a thin layer of sediment and thus are not readily discernable. The depths of these coal tar waste deposits are unknown.

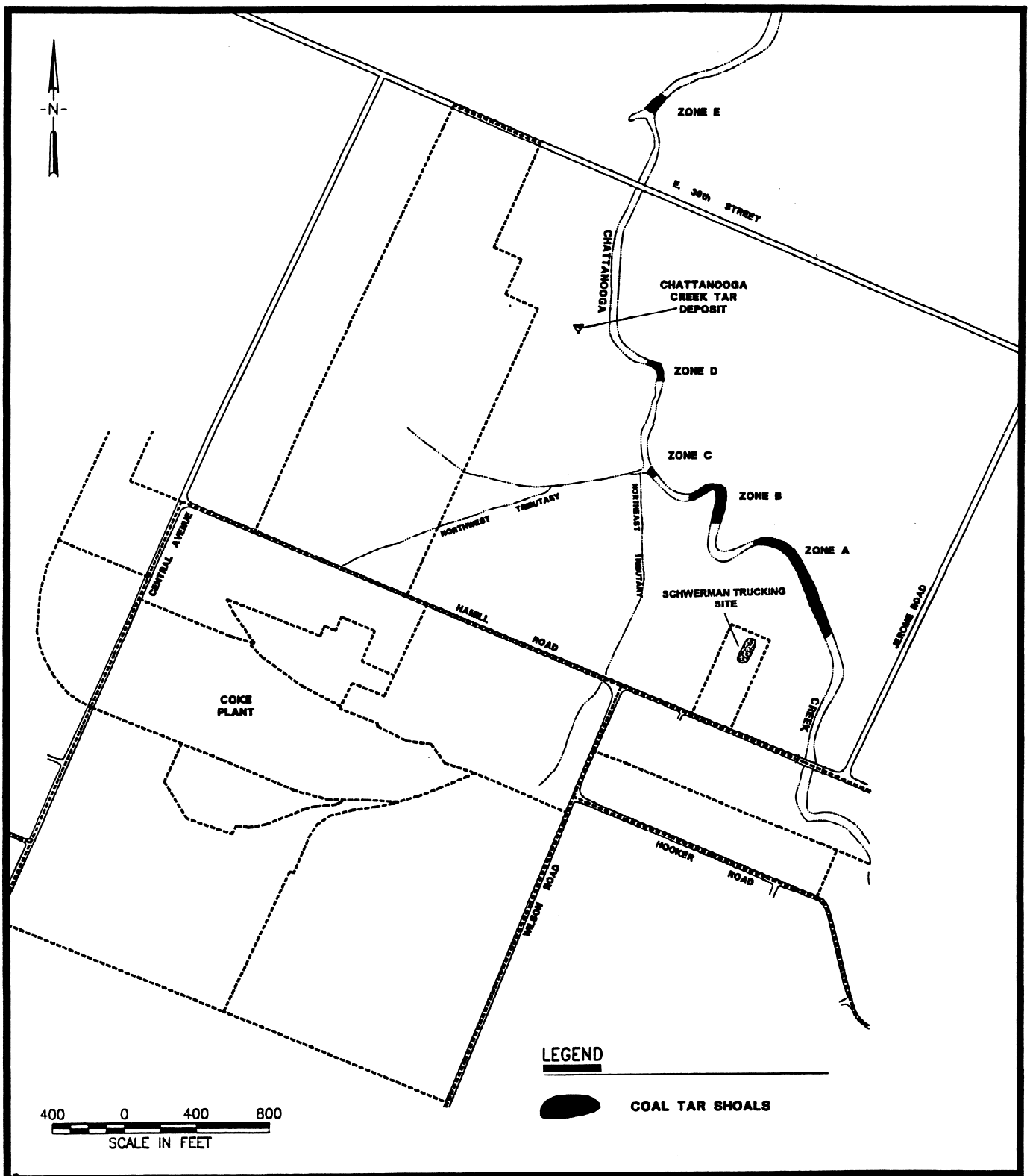
3.1.2 DEMOGRAPHY

The site is located in Census Tract 19. According to 1990 census data, 5,331 people reside in this tract. The population is 98 percent African-American and 1 percent Caucasian. Approximately 36 percent are under the age of 18, and 87 percent are under the age of 65.

3.1.3 LAND USE

The site is located in a heavily industrialized part of the city. In 1985, land use in Census Tract 19 was as follows:

- 18.7% residential
- 15.4% industrial



COAL TAR WASTE DEPOSIT LOCATIONS IN CHATTANOOGA CREEK

Tennessee Products Site
Chattanooga, Tennessee

CDM FEDERAL PROGRAMS CORPORATION
a subsidiary of Camp Dresser & McKee Inc.

FIGURE No. 3-4

coaltar/14JUN96/800

- 3.7% commercial
- 0.2% agricultural
- 62.0% undeveloped

The urban Chattanooga Creek Valley has a long history of industrial development. Much of that development was located near, or in the floodplain of the creek. Therefore, much of the former wetlands in the lower valley have been filled and used by industry. Although several public housing projects and many individual residences are nterspersed within the industrial facilities, the site is shown as "industrial" in a land use plan spanning the years 1994-2010 (Chatanooga/Hamilton County Regional Planning Agency 1994).

The creek has historically been subjected to gross pollution by industrial waste discharges from coke production, organic chemical manufacturing, metallurgical and foundry works, tannery operations, and wood treating facilities. Additionally, some members of the public continue to use the creek and floodplain as a solid waste dumping ground. Within the boundaries of the site, a portion of the floodplain remains wooded and undeveloped.

Numerous schools and recreation centers exist in the area. The nearest are an elementary school located approximately 0.2 miles east of the Coke Plant, and a middle school located approximately 0.75 miles northeast of the Coke Plant and adjacent to the creek. The Alton Park Recreation Center is located approximately 0.2 miles north of the Coke Plant and has children's playground facilities.

3.1.4 AREA WATER USE

Private drinking water wells are not known to exist within a 4-mile radius of the site. Drinking water for the area is supplied by the Tennessee-American Water Company whose intake is on the Tennessee River approximately four miles upstream of the confluence of Chattanooga Creek and the Tennessee River. Groundwater is also not known to be used for irrigation or livestock watering in this urban area. The closest active industrial wells to the site are Southern Cellulose Products' two wells (both 150 feet deep) on 38th Street, and the Chattanooga Glass Company well (325 feet deep) on West 45th Street.

There are no known nearby surface water withdrawals (for drinking water) located downstream of the site in Chattanooga Creek or the Tennessee River. The closest downstream public water withdrawal intake is located in South Pittsburg, Tennessee, on the Tennessee River, approximately 30 river-miles downstream from the confluence of Chattanooga Creek and the Tennessee River. Chattanooga Creek is used for swimming, playing, and fishing by both children and adults, although warning signs are posted. Consumption of fish caught from the creek has been reported. In addition, homeless people are reported to be bathing in the creek and drinking the creek water.

3.1.5 CLIMATE

The climate of the area is generally mild. Cold air currents moving south from Canada and warm air currents moving north from the Gulf of Mexico affect the daily changes and seasonal variations in the weather.

Based on a 40 year period of record, the average annual temperature is 59.7 degrees Fahrenheit (^{o}F), the average annual precipitation is 52.6 inches, and the average annual number of frost-free days is 215. The temperature is generally in the 30 to 50^{o}F range in the winter, and the 70 to 90^{o}F range in the summer. July is the hottest month, with an average temperature of 78.7^{o}F, and January is the coldest month, with an average temperature of 38.7^{o}F. The wettest month is March, with an average rainfall of 6.31 inches, and the driest month is October, with an average rainfall of 2.92 inches.

3.1.6 SITE SOILS

The site lies entirely within the floodplain of Chattanooga Creek. Therefore, soils are comprised entirely of alluvial deposits in both the creek bed and along the terraces. Soils in the upstream portion of the site consist primarily of Tupelo silty loam. The Tupelo, according to the Soil Conservation Service (SCS), is characteristically a deep, somewhat poorly drained soil which rarely has slopes greater than three percent. Typically, the surface layer is a yellowish-brown silty loam approximately eight inches thick. The subsoil generally extends to a depth of approximately 48 inches.

Downstream of the Tupelo soils, north of the 38th Street Bridge, the soils grade into the Newark Series. They also are poorly drained, nearly level soils commonly found in floodplains and depressions. Slopes range up to 3 percent, but commonly are less than 2 percent. The Newark's surface layer is typically a dark grayish-brown silt loam about six inches thick. The subsoil is generally about 2 1/2 feet thick and in its upper part is a mottled brown to grayish-brown silty loam.

Near the Chattanooga Creek's confluence with Dobbs Branch, the SCS classifies the soils into the Colbert-Urban Land Complex Series. This unit consists of deep, moderately well-drained, gently sloping Colbert soils, urban land, and disturbed areas as a result of construction activities. This unit can occasionally be found further upstream within the Tupelo and Newark soil units. Near Dobbs Branch, Colbert soils make up 25 to 45 percent of the land surface, urban development approximately 25 to 45 percent and disturbed areas about 10 to 25 percent. Typically, Colbert soils have a surface layer of brown silt loam four inches thick. The subsoil is a yellowish-brown clay that is mottled in its lower part. It is generally about four feet thick.

3.1.7 REGIONAL HYDROGEOLOGY

Groundwater in the region occurs within both the unconsolidated and consolidated materials. The unconsolidated materials include the alluvial deposits and residuum described above. These materials generally have low water yield and are thus not considered an important groundwater source.

The consolidated materials consist of shale, sandstone, limestone, and dolomite that form the bedrock. These features occur erratically and cause hydraulic conductivities to be extremely variable throughout the region. Shales generally have low yields. Sandstones, particularly those on Lookout Mountain, may yield large quantities of water. Limestones and dolomites produce variable amounts of water depending on the number and size of fractures and solution cavities encountered.

Groundwater is recharged primarily by the percolation of rainwater through the soils. Generally, groundwater discharges locally to ponds, streams (such as Chattanooga Creek), springs, and by general seepage.

3.1.8 REGIONAL HYDROLOGY

Chattanooga Creek is in the Tennessee River basin, which is regulated by a series of dams along the river and large tributary dams in the headwaters. Chattanooga Creek originates from the slopes of Georgia's Lookout Mountain, flows approximately 26 miles northward into Tennessee and eventually into the Tennessee River, just downstream of downtown Chattanooga, and above Nickajack Lake. Nickajack Lake is formed by the Tennessee Valley Authority (TVA) hydroelectric dam at river-mile 425.

The creek is a gaining stream throughout its course and in its Georgia headwaters is fed by several springs. The creek has a watershed of nearly 75 square miles, of which approximately 20 percent is in Tennessee. It occupies the northern portion of the Chattanooga Valley between Lookout Mountain and Missionary Ridge.

Average stream flow in Chattanooga Creek in Tennessee is on the order of 100 cubic feet per second (cfs). The creek falls about 1.5 feet per mile and is relatively shallow, usually not over 4 feet deep and in many places much less, on the order of 3 to 4 inches. The average depth appears to be 2 to 4 feet, except where artificially deepened. In the extremely shallow areas, a brisk current is evident, but along most of the length of creek in Tennessee, the current is scarcely discernable. The stream banks appear to average approximately 2 to 4 feet, except where artificially heightened. Periodic flooding occurs, as evidenced by trash entangled in trees and bushes 3 to 4 feet above the normal stream level.

The topography of the surrounding area of Chattanooga Creek is rough and mountainous, promoting a special susceptibility of the stream to overflow due to heavy, short duration, spring and summer storms. Floodplain development is considered to be heavy in the Chattanooga Creek basin. Backwater from severe Tennessee River floods could extend up the entire length of Chattanooga Creek. Headwater flooding prevails along Chattanooga Creek but has not been a major problem. In the past, Tennessee River backwater has caused heavy flood damage to the highly developed floodplain. Schwerman

Trucking Site, Chattanooga Creek Tar Deposit, and a small portion (less than 1 acre) of the coke production facility are all located within the 100-year flood plain.

3.1.9 ECOLOGICAL SETTING

The riparian and wetland habitat/ecosystem of Chattanooga Creek forms an important greenway through the city of Chattanooga. Even with its problems, this stream is particularly valuable for overwintering migratory waterfowl. The many functions and values associated with the wetlands of Chattanooga Creek are valuable in this urban setting due to the extensive industrial and metropolitan development.

3.1.9.1 Aquatic Habitat

Aquatic habitat in the project area includes Chattanooga Creek and its associated oxbows, beaver ponds, excavated borrow pits and riparian forested areas that are seasonally flooded. Chattanooga Creek possesses a fairly diverse habitat which includes logs, snags, bank overhangs, pools and riffles located upstream of the 38th Street Bridge. Below the 38th Street Bridge, and especially from Dobbs Branch downstream, the creek has less habitat diversity where channelization has occurred. Additionally, these waters exhibit low dissolved oxygen and can be anaerobic due to the biological oxygen demand from the sewage and wastes carried by the numerous storm sewers and outfalls that empty into this reach. In this section, the main stream channel is the primary habitat type and there are few snags, no riffles and no bank overhangs. Also, the stream flow is diminished and the substrate has changed from the rubble, gravel and coarse sand substrate that is visible in the upstream reaches. The creek bed is characterized by a silty and organic laden substrate in the downstream reaches below 38th Street.

Substrate is an important factor in determining the composition of the macroinvertebrate fauna since the coarser substrates are preferred by benthic fauna. Silts not only impact the fish community by elimination of spawning areas, but also by decreasing their food supply of benthic macroinvertebrates.

Chattanooga Creek is classified for "Fish and Aquatic Life" from its mouth to the state line. Under water quality criteria rules for the Tennessee Department of Environment and Conservation (September 1991), for "Fish and Aquatic Life" classification, "bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life" are prohibited.

It is evident from biological studies that disruption of the fauna has occurred and is continuing to occur in the lower reaches of Chattanooga Creek and that the impacts have affected the balance of the aquatic community and retarded the attainment of a viable fish and aquatic community.

3.1.9.2 Terrestrial Habitat

Terrestrial riparian habitat in the vicinity of Chattanooga Creek consists of a stream side border of woody vegetation composed of mixed hardwood trees, shrubs, soft- stemmed or herbaceous species and grasses. Trees in various sample areas averaged 40 to 80 feet in height. The riparian forested width varies from a narrow fringe to an approximate 200 yard wide maximum. Undeveloped areas without trees are the result of fields that have become overgrown with grasses, weeds and other herbaceous species.

3.1.10 AIR QUALITY

Ambient air quality in the vicinity of Chattanooga Creek has been a major concern for residents and local environmental agencies for decades. The combination of frequent air inversions and emissions of numerous industries in the area resulted in poor air quality. However, air quality in the area has improved in the last decade. Fourteen industries in South Chattanooga are under air pollution control permits, and Chattanooga currently meets all federal criteria pollutant standards for the six criteria pollutants (sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulates).

Chattanooga has been designated "in attainment" since 1984 for particulates and since 1989 for ozone by EPA.

3.2 CONCEPTUAL SITE MODEL

The conceptual site model incorporates information on the potential chemical sources, affected media, release mechanisms, potential exposure pathways, and known receptors to identify complete exposure pathways. A pathway is considered complete if (1) there is a source or chemical release from a source; (2) there is an exposure point where contact can occur; and (3) there is a route of exposure (oral, dermal, or inhalation) through which the chemical may be taken into the body.

The primary sources of contamination at the site are wastes associated with the production and disposal of coal tar products described in Section 3.1.1. Contaminants released as a consequence of these actions serve as a reservoir for continued release to surface water and sediment via erosion or solubilization; to groundwater via the leaching action of infiltrating rain water; and to air via dust generation or volatilization of contaminants. The conceptual site model for this assessment is presented in **Table 3-1**. Based on this model, the media available for human contact are:

(1). Surficial soil on- and off-site. Potential current receptors are site visitors (on-site) and residents (off-site). In the future, the site may be redeveloped as commercial/industrial

Table 3-1
Site Conceptual Model
Tennessee Products Site
Chattanooga, Tennessee

Source	Primary Release / Transport Mechanism	Affected Medium	Exposure Point	Exposure Route	Receptor
Coke	NA	Surface Soil	Coke Plant Area Schwerman Trucking Site Chattanooga Creek Tar Deposit Northeast Tributary Area Off-site Residential Areas	Ingestion Dermal Contact	Visitor (1) Worker (1) Resident (2)
Production	Surface Runoff and Aquifer Connection to Surface Water/Wetlands	Surface Water	Coke Plant Area Northeast Tributary Area Northwest Tributary Area	Ingestion Dermal Contact	Visitor
		Sediment	Coke Plant Area Northeast Tributary Area Northwest Tributary Area Upper, Middle, and Lower Reaches Chattanooga Creek	Ingestion Dermal Contact	Visitor (3) Resident (4)
Wastes	Leaching	Groundwater	Coke Plant Area Schwerman Trucking Site Adjacent to Middle Reach Chattanooga Creek	Ingestion Inhalation of VOCs	Worker Resident
	Dust Generation	Air	Coke Plant Area Schwerman Trucking Site Chat. Creek Tar Deposit Northeast Tributary Area Off-site Residential Areas	Inhalation	Visitor (1) Worker (1) Resident (2)

(1) Coke Plant Area, Schwerman Trucking Site, Chattanooga Creek Tar Deposit, and Northeast Tributary only.
(2) Off-site residential areas only.
(3) Coke Plant Area, Northeast Tributary, and Northwest Tributary only.
(4) Upper, Middle, and Lower Reaches Chattanooga Creek only.

NA Not applicable

property and on-site workers could be exposed. Note that residential exposure to soil on-site is not included since this is an unlikely future use of the property (Chatanooga/Hamilton County Regional Planning Agency 1994);

(2). Surface water on- and off-site. Potential current and future receptors are site visitors and residents;

(3). Sediment on- and off-site. Potential current and future receptors are site visitors and residents;

(4). Groundwater on-site. Potential future receptors are on-site workers. Risks associated with residential exposures to groundwater were evaluated relative to off-site migration of the plume to residential areas; and

(5). Air on- and off-site. Dust released from on-site soil may impact site visitors (current use) and on-site workers (future use). Dust released from residential areas off-site may impact current residents.

Note that a potentially complete exposure pathway to surface water in Chattanooga Creek was not examined in this risk assessment. The reason for this is that the main concern with Chattanooga Creek has been the extensive and obvious contamination in the sediments with coal tar wastes. As a result, the investigations to date have focused on the sediments and no surface water data are available. The ultimate remedy for the contamination in Chattanooga Creek will entail cleanup of the sediments. This in turn will result in source control of contamination in the surface water, eliminating it as a potentially complete exposure pathway.

In summary, potentially complete exposure pathways examined in this risk assessment are:

- ingestion of soil,
- dermal contact with soil,
- ingestion of surface water (other than Chattanooga Creek),
- dermal contact with surface water (other than Chattanooga Creek),
- ingestion of sediment (on-site and in Chattanooga Creek),
- dermal contact with sediment (on-site and in Chattanooga Creek),
- ingestion of groundwater,

- inhalation of volatile organic compounds (VOCs) released from groundwater, and
- inhalation of dust.

3.3 QUANTIFICATION OF EXPOSURE

3.3.1 EXPOSURE POINT CONCENTRATIONS

Reasonable maximum exposure (RME) point concentrations for were calculated according to EPA Region 4 guidance using the lesser of the 95 percent upper confidence limit (UCL) on the arithmetic average for a lognormal distribution or the maximum detected value (EPA, 1992b and 1995a). Where a COPC was not detected at a given location, one-half the SQL was used as a proxy concentration; however, if both the proxy concentration and the UCL exceeded the maximum detected value, the maximum detected value was used as the RME concentration. The RME concentrations for COPCs in each area are presented in the appropriate appendix. An example RME calculation is provided in **Appendix H**.

3.3.2 HUMAN INTAKES

Human intakes were calculated for each chemical and receptor using the RME concentrations. Estimates of human intake, expressed in terms of mass of chemical per unit body weight per time (mg/kg-day), are calculated differently depending on whether the COPC is a non-carcinogen or a carcinogen. For non-carcinogens, intake is averaged over the duration of exposure and is referred to as the average daily dose (ADD). For carcinogens, intake is averaged over the average lifespan of a person (70 years) and is referred to as the lifetime average daily dose (LADD). Chemical-specific intakes for each pathway are provided in the respective appendix. Intake equations and sample calculations may be found in Appendix H.

ADDs and LADDs were calculated using standard assumptions and professional judgment. The assumptions that were used in calculating intakes of are:

- **Body weight.** The body weights for the adult and the child receptors are 70 kg and 15 kg, respectively, in accordance with the guidance in EPA's *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991). The site visitor is assumed to be between the ages of 7 and 16. Based on professional judgment, a body weight of 45 kg was selected for the site visitor receptor.

- **Averaging time.** Based upon information in RAGS (EPA, 1989a) for non-carcinogens, intakes are calculated by averaging the total cumulative dose over the exposure duration to yield an average daily intake. For the site worker (exposure duration 25 years), the averaging time is 9,125 days, and for the site visitor (exposure duration 10 years) the averaging time is 3,650 days. For the child resident (exposure duration 6 years) the averaging time is 2,190 days, and for the adult resident (exposure duration 24 years) the averaging time is 8,760 days. To calculate noncarcinogenic effects over a lifetime of exposure, an intake factor is calculated to account for the varying exposure rates and body weights over a lifetime (30 years).

  For carcinogens, intakes are calculated by averaging the total cumulative dose over a 70-year lifetime, an averaging time of 25,550 days, to yield a lifetime average daily intake.

- **Exposure frequency.** Exposure frequency varies based on the media available for contact as follows:

  Soil and dust (air) The site visitor is assumed to visit the site 1 day/month for 12 months/year, or 12 days/year. This exposure frequency was used for the site visitor in assessing exposure to on-site surface soil and dust. Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991), the standard default value of frequency of exposure for a site worker is 250 days/year. Also according to this document, the standard default value of frequency of exposure for residential land use is 350 days/year. Therefore, these values were used for the on-site worker and off-site child and adult resident receptors to assess exposure to soil and dust.

  Surface water and sediment Child and adult residents were assumed to visit Chattanooga Creek 4 times/month for 3 months/year (summer months), or 12 visits/year. This exposure frequency was also used for the site visitor in assessing exposure to surface water and sediment in onsite streams.

  Groundwater and VOCs Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991), the standard default value of frequency of exposure for a site worker is 250 days/year. Also according to this document, the standard default value of frequency of exposure for residential land use is 350 days/year. Therefore, these values were used for hypothetical onsite workers, child residents, and adult residents to assess exposure to

groundwater. Hypothetical adult residents were assumed to be exposed to VOCs from showering for 350 days/year.

- **Exposure duration.** The exposure duration value for the site visitor from ages 7 to 16 is 10 years. This value is based on professional judgment. Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991), the standard default value of duration of exposure for commercial/industrial land use is 25 years. This value was used in assessing exposure for on-site workers. Also according to this document, the standard default value of duration of exposure for residential land use is 24 years for adults and 6 years for children. These values were used in assessing exposure for the adult and child receptors. An exposure duration of 30 years was used to assess lifetime exposure to noncarcinogens.

- **Soil ingestion rate.** The ingestion rate of surficial soils for the site visitor was assumed to be 100 milligrams (mg)/visit. Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991), the standard default value for soil ingestion in a commercial/ industrial setting is 50 mg/workday. This value was selected for the on-site worker receptor. Also according to this document, the ingestion rates of surficial soils for the child and adult residents are 100 and 200 mg/day, respectively. An age-adjusted intake factor was used to calculate non-cancer risk for lifetime residents.

- **Surface water ingestion rate.** The site visitor is assumed to spend 2 hours at each stream during each visit, incidentally ingesting surface water at 50 milliliters (ml)/hour while wading. The daily surface water ingestion rate is therefore 100 ml/day.

- **Sediment ingestion rate.** The child resident, adult resident, and site visitor are assumed to incidentally ingest sediment at 100 mg per visit.

- **Inhalation rate.** Based upon information in EPA documents, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991) and *Exposure Factors Handbook* (EPA, 1989b), the standard default inhalation factor for a worker in a commercial/industrial land use setting is 20 cubic meters (m^3) of air per workday. Also according to this document, the inhalation rates of adults and children under a residential land-use scenario are 20 m^3 of air per day and 15 m^3 of air per day, respectively. The inhalation factor for the site visitor was assumed to be the same as an adult, or 20 m^3 of air per day.

- **Surface area.** Available exposed skin area for a adult resident exposed to sediment in Chattanooga Creek is assumed to be limited to his feet, lower legs, hands, and forearms. According to the *Exposure Factors Handbook* (EPA, 1989b), the skin area of an adult male's feet, lower legs, hands, and forearms is approximately 8,620 cm^2. For a 6- to 7-year old boy, this surface area is 3,910 cm^2. These values were used for the adult and child resident

receptors. An age-adjusted dermal factor was used to calculate non-cancer risk for lifetime residents. The surface area for an adult (8,620 cm^2) was used for a site visitor as well. Exposed skin area for an on-site worker exposed to soil was assumed to be limited to the hands and forearms. This assumption is based on the type of activities at this site and the general attire related to those types of activities. According to the *Exposure Factors Handbook* (EPA, 1989b), the skin area for an adult male's hands and forearms is approximately 1,980 cm^2.

- **Adherence factor.** The soil-to-skin adherence factor in assessing dermal exposure is between 0.2 and 1.0 mg/cm^2 according to EPA guidance (EPA, 1995a). Since site-specific values are not available, 1.0 mg/cm^2 was conservatively selected.

- **Permeability constants.** For dermal contact with surface water, dermal permeability constants were taken from the EPA document *Dermal Exposure Assessment, Principles and Applications (Interim Report)* (EPA, 1992c).

- **Groundwater ingestion rate.** Based upon information in the EPA document, *Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"* (EPA, 1991), the standard default value of water ingestion for a site worker is 1 l/day. Also according to this document, the standard default value of water ingestion for an adult resident is 2 l/day. A child resident was assumed to drink 1 l/day.

- **VOC inhalation rate.** Based on information in *Supplemental Guidance to RAGS: Region 4 Bulletins*, exposure to VOCs during showering is equivalent to exposure of 2 l/day of contaminated water (EPA, 1995a). Therefore, this value was used for the hypothetical adult resident receptors.

3.4 UNCERTAINTIES OF EXPOSURE ASSESSMENT

Two aspects of the exposure assessment contribute a considerable degree of uncertainty to the risk assessment. First, actual exposure frequencies are unknown; estimates were based on available guidance. Actual exposure is not expected to exceed the values presented but may be much lower. The use of conservative assumptions in the exposure assessment is believed to result in an overestimate of risk. Second, lacking data, it was not possible to assess potential risk attributable to exposure to Chattanooga Creek surface water. Generally, such exposures do not contribute a great deal toward the total risk/hazard. However, the absence this data increases uncertainty and raises the possibility that the risk/hazard attributable to such exposure may be biased low to a small degree.

4.0 TOXICITY ASSESSMENT

Toxicity assessment is a two-step process whereby the potential hazards associated with route-specific exposure to a given chemical are (1) identified by reviewing relevant human and animal studies; and (2) quantified through analysis of dose-response relationships. EPA has conducted numerous toxicity assessments that have undergone extensive review within the scientific community.

4.1 TOXICITY VALUES

EPA toxicity assessments and the resultant toxicity values will be used in the baseline evaluation to determine both carcinogenic and non-carcinogenic risks associated with each chemical of concern and route of exposure. EPA toxicity values that are used in this assessment include:

- reference dose values (RfDs) for non-carcinogenic effects
- cancer slope factors (CSFs) for carcinogenic effects

RfDs have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting non-carcinogenic (systemic) effects. RfDs are ideally based on studies where either animal or human populations were exposed to a given compound by a given route of exposure for the major portion of the life span (referred to as a chronic study). The RfD is derived by determining dose-specific effect levels from all the available quantitative studies, and applying uncertainty factors to the most appropriate effect level to determine an RfD for humans. The RfD represents a threshold for toxicity. RfDs are derived such that human lifetime exposure to a given chemical via a given route at a dose at or below the RfD should not result in adverse health effects, even for the most sensitive members of the population.

CSFs are route-specific values derived only for compounds that have been shown to cause an increased incidence of tumors in either human or animal studies. The CSF is an upper bound estimate of the probability of a response per unit intake of a chemical over a lifetime and is determined by low-

dose extrapolation from human or animal studies. When an animal study is used, the final CSF has been adjusted to account for extrapolation of animal data to humans. If the studies used to derive the CSF were conducted for less than the life span of the test organism, the final CSF has been adjusted to reflect risk associated with lifetime exposure.

The RfDs and CSFs used in this assessment were primarily obtained from EPA's IRIS database (EPA, 1996b). Values that appear in IRIS have been extensively reviewed by EPA work groups and thus represent Agency consensus. If no values for a given compound and route of exposure were listed in IRIS, then EPA's HEAST (EPA, 1995b) were consulted. Where no value was listed in either IRIS or HEAST, EPA's National Center for Environmental Assessment (formerly the Environmental Criteria and Assessment Office) was consulted. **Tables 4-1** and **4-2** summarize the toxicity values for carcinogenic and non-carcinogenic COPCs, respectively. Brief toxicological profiles of the COPCs may be found in **Appendix I**.

To characterize risk associated with dermal exposure, the toxicity values presented in Tables 4-1 and 4-2 were adjusted from administered to absorbed toxicity factors according to the method described in Appendix A to RAGS (EPA, 1989a). The following oral absorption percentages were employed: 80 percent for VOCs, 50 percent for semi-volatile organics, and 20 percent for inorganics (EPA, 1995a).

4.2 UNCERTAINTIES RELATED TO TOXICITY INFORMATION

RfDs and CSFs for the COPCs were derived from EPA sources. RfDs are determined with varying degrees of uncertainty depending on such factors as the basis for the RfD (no-observed-adverse-effect-level, NOAEL vs. lowest-observed-adverse-effect-level, LOAEL),

Table 4-1
Cancer Slope Factors, Tumor Sites and EPA Cancer Classifications for
Chemicals of Potential Concern
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Cancer Slope Factor					Tumor Sites	EPA Class
	CSFo		ABSeff	CSFd	CSFi		
Arsenic	1.5E+00	i	20%	7.5E+00	1.51E+01	Skin	A
Barium	NA		20%	NA	NA	NA	D
Beryllium	NA	i	20%	NA	8.4E+00	All sites	B2
Cadmium	NA		20%	NA	6.3E+00	Lung	B2
Cobalt	NA		20%	NA	NA	NA	D
Chromium	NA		20%	NA	4.2E+01	Lung	A
Copper	NA		20%	NA	NA	NA	D
Nickel	NA		20%	NA	NA	NA	D
Lead	NA		20%	NA	NA	Kidney	B2
Antimony	NA		20%	NA	NA	NA	D
Thallium	NA		20%	NA	NA	NA	D
Vanadium	NA		20%	NA	NA	NA	D
Zinc	NA		20%	NA	NA	NA	D
Mercury	NA		20%	NA	NA	NA	D
Aluminum	NA		20%	NA	NA	NA	D
Manganese	NA		20%	NA	NA	NA	D
Iron	NA		20%	NA	NA	NA	D
Cyanide	NA		20%	NA	NA	NA	D
1,3-Dichlorobenzene	NA		80%	NA	NA	NA	D
1,4-Dichlorobenzene	2.4E-02	h	80%	3.0E-02	NA	Liver	B2
1,2-Dichlorobenzene	NA		80%	NA	NA	NA	D
1,2,4-Trichlorobenzene	NA		NA	NA	NA	NA	D
Naphthalene	NA		50%	NA	NA	NA	D
Acenaphthylene	NA		50%	NA	NA	NA	D
Acenaphthene	NA		50%	NA	NA	NA	D
Fluorene	NA		50%	NA	NA	NA	D
Hexachlorobenzene	1.6E+00	i	80%	2.0E+00	NA	Liver, thyroid, kidney	B2
Phenanthrene	NA		50%	NA	NA	NA	D
Anthracene	NA		50%	NA	NA	NA	D
Fluoranthene	NA		50%	NA	NA	NA	D
Pyrene	NA		50%	NA	NA	NA	D
Bis(2-ethylhexyl)phthalate	1.4E-02	i	50%	2.8E-02	NA	Liver	B2
Benzo(a)anthracene	7.3E-01	n	50%	1.5E+00	6.1E-01	Forestomach	B2
Chrysene	7.3E-03	n	50%	1.5E-02	6.1E-03	Forestomach	B2
Benzo(b &/or k)fluoranthene	7.3E-01	i	50%	1.5E+00	6.1E-01	Forestomach	B2
Benzo(a)pyrene	7.3E+00	i	50%	1.5E+01	6.1E+00	Forestomach	B2
Indeno(1,2,3-cd)pyrene	7.3E-01	n	50%	1.5E+00	6.1E-01	Forestomach	B2

Sources:
i - IRIS
h - HEAST
n - NCEA

EPA Cancer Classes

A - Human carcinogen
B - Probable human carcinogen
C - Possible human carcinogen
D - Not classifiable as a human carcinoge

CSFo - Cancer Slope Factor (oral), (mg/kg/day)-1
CSFd - Cancer Slope Factor (dermal), (mg/kg/day)-1
ABSeff - Absorption efficiency: 20% inorganics, 50% semiviolatiles, 80% volatiles
NA - Not applicable (no data)

Toxicity value surrogates:
pyrene used for acenaphthylene, benzo(g,h,i)perylene, phenanthrene
naphthalene used for 2-methlynaphthalene
gamma BHC used for delta BHC
benzo(b)fluoranthene used for benzo(k)fluoranthene

Table 4-1
Cancer Slope Factors, Tumor Sites and EPA Cancer Classifications for
Chemicals of Potential Concern
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Cancer Slope Factor					Tumor Sites	EPA Class
	CSFo		ABSeff	CSFd	CSFi		
Dibenzo(a,h)anthracene	7.3E+00	n	50%	1.5E+01	6.1E+00	Forestomach	B2
Benzo(g,h,i)perylene	NA		50%	NA	NA	NA	D
Phenol	NA		50%	NA	NA	NA	D
2,4-Dimethylphenol	NA		50%	NA	NA	NA	D
2-Methylnaphthalene	NA		50%	NA	NA	NA	D
Dibenzofuran	NA		50%	NA	NA	NA	D
3-Nitroaniline	NA		50%	NA	NA	NA	D
2-Methylphenol	NA		50%	NA	NA	NA	D
(3- &/or 4-)Methylphenol	NA		50%	NA	NA	NA	D
Carbazole	2.0E-02		50%	4.0E-02	NA	Liver	B2
Aldrin	1.7E+01	i	50%	3.4E+01	1.7E+01	Liver	B2
Heptachlor epoxide	9.1E+00		50%	1.8E+01	9.1E+00	Liver	B2
Alpha-BHC	6.3E+00	i	50%	1.3E+01	6.3E+00	Liver	B2
Beta-BHC	1.8E+00	i	50%	3.6E+00	1.8E+00	Liver	B2
Gamma-BHC (Lindane)	1.3E+00	h	50%	2.6E+00	NA	Liver	B2
Delta-BHC	1.3E+00	h	50%	2.6E+00	NA	Liver	B2
Dieldrin	1.6E+01	i	50%	3.2E+01	1.6E+01	Liver	B2
4,4'-DDT (p,p'-DDT)	3.4E-01	i	50%	6.8E-01	NA	Liver	B2
PCB-1254	NA		50%	NA	NA	NA	D
PCB-1248	7.7E+00	i	50%	1.5E+01	NA	Liver	B2
PCB-1260	7.7E+00	i	50%	1.5E+01	NA	Liver	B2
Gamma-Chlordane	1.3E+00	i	50%	2.6E+00	NA	Liver	B2
2,3,7,8-TCDD	1.6E+05	h	50%	3.1E+05	1.16E+05	Liver	B2
Chloroform	6.1E-03	i	80%	7.6E-03	8.1E-02	Liver	B2
1,2-Dichloroethane	9.1E-02	i	80%	1.1E-01	9.1E-02	Liver	B2
1,2-Dichloroethene	NA		80%	NA	NA	NA	D
1,1,1-Trichloroethane	NA		80%	NA	NA	NA	D
Carbon tetrachloride	1.3E-01	i	80%	1.6E-01	5.3E-02	Liver	B2
Trichloroethene	1.1E-02	w	80%	1.4E-02	6.0E-03	Liver	NA
Benzene	2.9E-02	i	80%	3.6E-02	2.9E-02	Leukemia	A
Tetrachloroethene	5.2E-02	n	80%	6.5E-02	2.0E-03	Liver	NA
Toluene	NA		80%	NA	NA	NA	D
Chlorobenzene	NA		80%	NA	NA	NA	D
Ethylbenzene	NA		80%	NA	NA	NA	D
Acetone	NA		80%	NA	NA	NA	D
Methyl ethyl ketone	NA		80%	NA	NA	NA	D
Methyl butyl ketone	NA		80%	NA	NA	NA	D

Sources:
i - IRIS
h - HEAST
n - NCEA

EPA Cancer Classes

A - Human carcinogen
B - Probable human carcinogen
C - Possible human carcinogen
D - Not classifiable as a human carcinoge

CSFo - Cancer Slope Factor (oral), (mg/kg/day)-1
CSFd - Cancer Slope Factor (dermal), (mg/kg/day)-1
ABSeff - Absorption efficiency: 20% inorganics, 50% semiviolatiles, 80% volatiles
NA - Not applicable (no data)

Toxicity value surrogates:
pyrene used for acenaphthylene, benzo(g,h,i)perylene, phenanthrene
naphthalene used for 2-methlynaphthalene
gamma BHC used for delta BHC
benzo(b)fluoranthene used for benzo(k)fluoranthene

Table 4-2
Reference Doses and Target Sites for
Chemicals of Potential Concern
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Reference Dose				Target Sites / Effects
	RfDo		ABSeff	RfDd	RfDi	
Arsenic	3E-04	i	20%	6E-05	NA	Hyperpigmentation
Barium	7E-02	a	20%	1E-02	1.43E-04	Incr. blood pressure
Beryllium	2E-03	i	20%	4E-04	NA	NOAEL
Cadmium	5E-04	i	20%	1E-04	5.71E-05	NOAEL
Cobalt	6E-02	n	20%	1E-02	NA	Not specified
Chromium	5E-03	i	20%	1E-03	NA	NOAEL
Copper	4E-02	n	20%	8E-03	NA	Not specified
Nickel	2E-02	i	20%	4E-03	NA	Decr. body/organ weights
Lead	NA		20%	NA	NA	CNS effects, blood
Antimony	4E-04	i	20%	8E-05	NA	Longevity, blood glucose
Thallium	9E-05	i	20%	2E-05	NA	Incr. serum enzymes
Vanadium	7E-03	i	20%	1E-03	NA	NOAEL
Zinc	3E-01	i	20%	6.00E-02	NA	
Mercury	3E-04	h	20%	6E-05	8.57E-05	NOAEL
Aluminum	1E+00	n	20%	2E-01	NA	Not specified
Manganese	2E-02	i	20%	5E-03	1.43E-05	NOAEL
Iron	3E-01	n	20%	6E-02	NA	NOAEL
Cyanide	5E-03	i	20%	1E-03	NA	NOAEL
1,3-Dichlorobenzene	9E-02	o	80%	7E-02	NA	NOAEL
1,4-Dichlorobenzene	NA		80%	NA	2E-01	Incr. liver weights
1,2-Dichlorobenzene	9E-02	i	80%	7E-02	9.00E-03	NOAEL
1,2,4-Trichlorobenzene	5E-04	n	80%	4E-04	NA	Incr. adrenal weights
Naphthalene	4E-02	w	50%	2E-02	NA	Not specified
Acenaphthylene	3E-02	i	50%	2E-02	NA	Not specified
Acenaphthene	6E-02	i	50%	3E-02	NA	Not specified
Fluorene	4E-02	i	50%	2E-02	NA	Decr. red blood cells
Hexachlorobenzene	8E-04	i	80%	6E-04	NA	Liver effects
Phenanthrene	3E-02	i	50%	2E-02	NA	Not specified
Anthracene	3E-01	i	50%	2E-01	NA	Not specified
Fluoranthene	4E-02	i	50%	2E-02	NA	Kidney, liver effects
Pyrene	3E-02	i	50%	2E-02	NA	Kidney effects
Bis(2-ethylhexyl)phthalate	2E-02	i	50%	1E-02	NA	Incr. liver weight
Benzo(a)anthracene	NA		50%	NA	NA	NA
Chrysene	NA		50%	NA	NA	NA
Benzo(b &/or k)fluoranthene	NA		50%	NA	NA	NA
Benzo(a)pyrene	NA		50%	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA		50%	NA	NA	NA

Sources:
i - IRIS
h - HEAST
n - NCEA
w - Withdrawn from IRIS or HEAST
a - HEAST Alternate
o - Other EPA Documents

Toxicity value surrogates:
pyrene used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene
naphthalene used for 2-methlynaphthalene
gamma BHC used for delta BHC
benzo(b)fluoranthene used for benzo(k)fluoranthene

RfDo - Reference Dose (oral), (mg/kg/day)
ABSeff - Absorption efficiency: 20% inorganics, 50% semiviolatiles, 80% volatiles
RfDd - Reference Dose (dermal), (mg/kg/day)
NA - Not Applicable (no data)

Table 4-2
Reference Doses and Target Sites for
Chemicals of Potential Concern
Tennessee Products Site
Chattanooga, Tennessee

Chemical of Potential Concern	Reference Dose				Target Sites / Effects
	RfDo		ABSeff	RfDd	RfDi	
Dibenzo(a,h)anthracene	NA		50%	NA	NA	NA
Benzo(g,h,i)perylene	3E-02	i	50%	2E-02	NA	Not specified
Phenol	6E-01	i	50%	3E-01	NA	Reduced fetal body weights
2,4-Dimethylphenol	2E-02	i	50%	1E-02	NA	Not specified
2-Methylnaphthalene	4E-02	w	50%	2E-02	NA	Not specified
Dibenzofuran	4E-03	n	50%	2E-03	NA	Not specified
3-Nitroaniline	3E-03	o	50%	2E-03	NA	Not specified
2-Methylphenol	5E-02	i	50%	3E-02	NA	Liver
(3- &/or 4-)Methylphenol	5E-02	i	50%	3E-02	NA	Liver
Carbazole	NA		50%	NA	NA	NA
Aldrin	3E-05	i	50%	2E-05	NA	Liver
Heptachlor epoxide	1E-05	i	50%	7E-06	NA	Liver weight increase
Alpha-BHC	NA		50%	NA	NA	NA
Beta-BHC	NA		50%	NA	NA	NA
Gamma-BHC (Lindane)	3E-04	i	50%	2E-04	NA	Liver, kidney
Delta-BHC	3E-04	i	50%	2E-04	NA	NA
Dieldrin	5E-05	i	50%	3E-05	NA	Liver
4,4'-DDT (p,p'-DDT)	5E-04	i	50%	3E-04	NA	Liver lesions
PCB-1254	2E-05	i	50%	1E-05	NA	Eyes, nails, immune syst.
PCB-1248	NA		NA	NA	NA	NA
PCB-1260	NA		NA	NA	NA	NA
Gamma-Chlordane	6E-05	i	50%	3E-05	NA	Liver hypertrophy
2,3,7,8-TCDD	NA		50%	NA	NA	NA
Chloroform	1E-02	i	80%	8E-03	NA	Liver
1,2-Dichloroethane	NA		80%	NA	NA	Liver
1,2-Dichloroethene	9E-03	h	80%	7E-03	NA	Liver
1,1,1-Trichloroethane	2E-02	n	80%	1E-02	2.86E-01	Liver
Carbon tetrachloride	7E-04	i	80%	4E-04	5.71E-04	Liver lesions
Trichloroethene	6E-03	n	80%	5E-03	NA	Liver
Benzene	NA	n	80%	NA	1.71E-03	Not specified
Tetrachloroethene	1E-02	i	80%	8E-03	NA	Liver
Toluene	2E-01	i	80%	2E-01	1.14E-01	Changes in liver, kidney
Chlorobenzene	2E-02	i	80%	1E-02	5.71E-03	Liver lesions
Ethylbenzene	1E-01	i	80%	8E-02	2.86E-01	Liver, kidney
Acetone	1E-01	i	80%	5E-02	NA	Incr. liver, kidney weights
Methyl ethyl ketone	6E-01	i	80%	5E-01	2.86E-01	Decr. fetal birth weights
Methyl butyl ketone	8E-02	i	80%	6E-02	2.29E-02	Liver

Sources:
i - IRIS
h - HEAST
n - NCEA
w - Withdrawn from IRIS or HEAST
a - HEAST Alternate
o - Other EPA Documents

Toxicity value surrogates:
pyrene used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene
naphthalene used for 2-methlynaphthalene
gamma BHC used for delta BHC
benzo(b)fluoranthene used for benzo(k)fluoranthene

RfDo - Reference Dose (oral), (mg/kg/day)
ABSeff - Absorption efficiency: 20% inorganics, 50% semiviolatiles, 80% volatiles
RfDd - Reference Dose (dermal), (mg/kg/day)
NA - Not Applicable (no data)

species (animal or human) and professional judgment. The calculated RfD is therefore likely overly protective, and its use results in an overestimation of non-cancer risk. Similarly, the CSFs developed by EPA are generally conservative and represent the upper-bound limit of the carcinogenic potency of each chemical.

5.0 RISK CHARACTERIZATION

The final step of the baseline risk assessment is the risk characterization. Human intakes for each exposure pathway (Section 3.0) are integrated with EPA reference toxicity values (Section 4.0) to characterize risk. Carcinogenic and non-carcinogenic effects are estimated separately.

To characterize the overall potential for non-carcinogenic effects associated with exposure to multiple chemicals, EPA uses a Hazard Index (HI) approach. This approach assumes that simultaneous subthreshold chronic exposures to multiple chemicals that affect the same target organ are additive and could result in an adverse health effect. The HI is calculated as follows:

$$\text{Hazard Index} = ADD_1/RfD_1 + ADD_2/RfD_2 + ...ADD_i/RfD_i$$

where: ADD_i = Average Daily Dose (ADD) for the ith toxicant

RfD_i = Reference Dose for the ith toxicant

The term ADD_i/RfD_i is referred to as the Hazard Quotient (HQ).

Calculation of an HI in excess of unity indicates the potential for adverse health effects. Indices greater than one will be generated anytime intake for any of the COPCs exceeds its RfD. However, given a sufficient number of chemicals under consideration, it is also possible to generate an HI greater than one even if none of the individual chemical intakes exceeds its respective RfD.

Carcinogenic risk is expressed as a probability of developing cancer as a result of lifetime exposure. For a given chemical and route of exposure, excess lifetime cancer risk is calculated as follows:

$$\text{Risk} = \text{Lifetime Average Daily Dose (LADD)} \times \text{Carcinogenic Slope Factor (CSF)}$$

These risks are probabilities that are generally expressed in scientific notation (i.e., 1×10^{-6} or 1E-6). An incremental lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper-bound, an individual

has a one-in-one-million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at the site. For exposures to multiple carcinogens, EPA assumes that the risk associated with multiple exposures is equivalent to the sum of their individual risks.

5.1 COKE PLANT

The Coke Plant is currently idle but is accessible to a site visitor. In the future, it may be redeveloped as commercial/industrial property.

5.1.1 CURRENT USE RISK SUMMARY

Exposure routes potentially complete are:

- inadvertent ingestion of soil
- dermal contact with soil
- inhalation of dust
- inadvertent ingestion of surface water (other than Chattanooga Creek)
- dermal contact with surface water (other than Chattanooga Creek)
- inadvertent ingestion of sediment (other than Chattanooga Creek)
- dermal contact with sediment (other than Chattanooga Creek)

Table 5-1 summarizes the cancer and non-cancer risks for a site visitor at the Coke Plant. The calculations may be found in Appendix A. The total incremental lifetime cancer risk estimate is 1×10^{-4}. EPA's acceptable target range for carcinogenic risk at Superfund sites is one-in-ten-thousand (1×10^{-4}) to one-in-one-million (1×10^{-6}). This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI less than one.

Table 5-1
Summary of Cancer and Noncancer Risks by Exposure Route
Current Use Scenario
Coke Plant Area
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor	
		Cancer	HI
Coke Plant Area (1)	Inadvertent Ingestion Soil	1E-05	0.02
	Dermal Contact Soil	2E-05	0.01
	Inhalation Dust	1E-05	0.02
	Inadvertent Ingestion Surface Water	2E-06	0.1
	Dermal Contact Surface Water	6E-05	0.02
	Inadvertent Ingestion Sediment	9E-06	0.01
	Dermal Contact Sediment	2E-05	0.03
	TOTAL RISK	**1E-04**	**0.2**

(1) Coke Plant Area surface soil samples: SS-01 through SS-19, and SS-21; SB-01A through SB-28A and SB-30A through SB-41A (60 locations)

Coke Plant Area surface water (SW) samples: SW-03, SW-04, and SW-05
Coke Plant Area sediment (SD) samples: SD-03, SD-04, and SD-05

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not Applicable

5.1.2 FUTURE USE RISK SUMMARY

In the future use scenario, the site may be redeveloped as commercial/industrial property. Since the site has been industrial property for most of this century, it is highly unlikely that it will ever be developed for any other use. In this future use scenario, ingestion of groundwater from wells developed from within the contaminant plume is considered as an additional exposure route to evaluate risks relative to off-site migration of the plume to residential areas. Note, however, that the risks associated with residential exposure to soil (i.e., ingestion, etc.) are not included since this is an unlikely future use of the property (Chatanooga/Hamilton County Regional Planning Agency 1994).

Table 5-2 summarizes the cancer and non-cancer risks for the future use scenario at the Coke Plant. The calculations are in Appendix A. The total incremental lifetime cancer risk estimate for a site worker is 1×10^{-3}. This estimate is above EPA's target range for Superfund sites. Ingestion of groundwater is the biggest factor, followed by inadvertent ingestion of soil and dermal contact with soil which contribute almost equally to overall risk. Inhalation of dust does not contribute appreciably to total risk. Non-cancer effects are possible based on an HI greater than one. Note that the future risk for a site visitor is the same as the current risk. Groundwater consumption is the sole factor in non-cancer risk.

The risks calculated using residential exposure assumptions for groundwater show a similar, but greater risk due to the higher exposure assumptions. Overall excess cancer risk ranges from 1×10^{-3} for a child resident to 4×10^{-3} for a lifetime resident. Non-cancer effects are possible based on HIs ranging from 49 to 63.

5.2 SCHWERMAN TRUCKING SITE

The Schwerman Trucking Site is accessible to a site visitor. In the future, it may be redeveloped as commercial/industrial property.

Table 5-2

Table 5-2
Summary of Cancer and Noncancer Risks by Exposure Route
Future Use Scenario
Coke Plant Area
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor		Site Worker		Child Resident		Adult Resident		Lifetime Resident	
		Cancer	HI	Cancer	HI	Cancer	HI	Cancer	HI	Cancer	HI
Coke Plant Area (1)	Inadvertent Ingestion Soil	1E-05	0.02	2E-04	0.1	NA	NA	NA	NA	NA	NA
	Dermal Contact Soil	2E-05	0.01	2E-04	0.04	NA	NA	NA	NA	NA	NA
	Inhalation Dust	1E-05	0.02	2E-06	0.00001	NA	NA	NA	NA	NA	NA
	Inadvertent Ingestion Surface Water	2E-06	0.1	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact Surface Water	6E-05	0.02	NA	NA	NA	NA	NA	NA	NA	NA
	Inadvertent Ingestion Sediment	9E-06	0.01	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact Sediment	2E-05	0.03	NA	NA	NA	NA	NA	NA	NA	NA
	Ingestion Groundwater	NA	NA	8E-04	10	1E-03	63	2E-03	27	3E-03	36
	Inhalation VOCs while Showering	NA	NA	NA	NA	NA	NA	6E-04	22	6E-04	22
	TOTAL RISK	**1E-04**	**0.2**	**1E-03**	**10**	**1E-03**	**63**	**3E-03**	**49**	**4E-03**	**58**

(1) Coke Plant Area surface soil samples: SS-01 through SS-19, and SS-21; SB-01A through SB-28A and SB-30A through SB-41A (60 locations)

Coke Plant Area surface water samples: SW-03, SW-04, and SW-05
Coke Plant Area sediment samples: SD-03, SD-04, and SD-05

Coke Plant Area groundwater samples: MW-01-SH, MW-01IN, MW-01DP, MW-02SH, MW-02-IN, MW-03-SH, MW-03-IN, MW-03-DP, MW-04SH, MW-07-SH, MW-07-IN, MD-05-12, MD-05-20, MD-05-102, MD-06-14, MD-06-73, MD-07-12, MD-07-51, MD-08-63, MD-09-20, VC-10, VC-11, VC-12, VC-13, VC-14, VC-15, VC-32, VC-33, VC-34, VC-35 (33 wells)

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not applicable

5.2.1 CURRENT USE RISK SUMMARY

Exposure routes potentially complete are:

- inadvertent ingestion of soil
- dermal contact with soil
- inhalation of dust.

Table 5-3 summarizes the cancer and non-cancer risks for a site visitor at Schwerman Trucking Site. The calculations may be found in Appendix B. The total incremental lifetime cancer risk estimate is 2×10^{-8}. This estimate is below EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI of less than one.

5.2.2 FUTURE USE RISK SUMMARY

In the future, this area may be developed as commercial/industrial property and wells for drinking water use constructed from within the contaminant plume; ingestion of water is thus considered as an additional exposure route. For comparison, the risks associated with residential exposure to groundwater are also presented, although the risks associated with residential exposure to soil are not included since this is an unlikely future use of the property.

Table 5-4 summarizes the cancer and non-cancer risks for the future use scenario at the Schwerman Trucking Site. The calculations may be found in Appendix B. The total incremental lifetime cancer risk estimate for a site worker is 8×10^{-5}. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are possible based on an HI greater than one. Groundwater consumption is the sole factor contributing to non-cancer risk. Note that the future risk for a site visitor is the same as the current risk.

The risks calculated using residential exposure assumptions for groundwater show greater risk due to the higher exposure assumptions. Overall excess cancer risk ranges from 1×10^{-4} for a child resident to 3×10^{-4} for a lifetime resident. These estimates are above EPA's target range

Table 5-3
Summary of Cancer and Noncancer Risks by Exposure Route
Current Use Scenario
Schwerman Trucking Site
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor	
		Cancer	HI
Schwerman Trucking (1)	Inadvertent Ingestion Soil	NA	0.002
	Dermal Contact Soil	NA	0.001
	Inhalation Dust	2E-08	NA
	TOTAL RISK	**2E-08**	**0.003**

(1) Surface soil (SS) samples: SS-36 through SS-43

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not Applicable

Table 5-4
Summary of Cancer and Noncancer Risks by Exposure Route
Future Use Scenario
Schwerman Trucking Site
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor		Site Worker		Child Resident		Adult Resident		Lifetime Resident	
		Cancer	HI	Cancer	HI	Cancer	HI	Cancer	HI	Cancer	HI
Schwerman Trucking (1)	Inadvertent Ingestion Soil	NA	0.002	NA	0.01	NA	NA	NA	NA	NA	NA
	Dermal Contact Soil	NA	0.001	NA	0.003	NA	NA	NA	NA	NA	NA
	Inhalation Dust	2E-08	NA	8E-07	NA	NA	NA	NA	NA	NA	NA
	Ingestion Groundwater	NA	NA	6E-05	13	9E-05	82	2E-04	35	2E-04	47
	Inhalation VOCs while Showering	NA	NA	NA	NA	NA	NA	NA	0.1	NA	0.1
	TOTAL RISK	**2E-08**	**0.003**	**6E-05**	**13**	**9E-05**	**82**	**2E-04**	**35**	**2E-04**	**47**

(1) Surface soil (SS) samples: SS-36 through SS-43
Groundwater (GW) samples: MW-10-SH, MW-10-IN, MW-11-SH, MW-11-IN

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not applicable

for Superfund sites. Non-cancer effects are possible for a residential use scenario based on HIs ranging from 35 to 82.

5.3 CHATTANOOGA CREEK TAR DEPOSIT

The Chattanooga Creek Tar Deposit is accessible to a site visitor. In the future, it may be redeveloped as commmercial/industrial property.

5.3.1 CURRENT USE RISK SUMMARY

Exposure routes potentially complete are:

- inadvertent ingestion of soil
- dermal contact with soil
- inhalation of dust

Table 5-5 summarizes the cancer and non-cancer risks for a site visitor at the Chattanooga Creek Tar Deposit. The calculations may be found in Appendix C. The total incremental lifetime cancer risk estimate is 2×10^{-6}. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI of less than one.

5.3.2 FUTURE USE RISK SUMMARY

In the future, this area may be developed as commercial/industrial property. Note that ingestion of water from on-site wells is not considered as an additional exposure route because no COPCs were identified in monitor wells near the deposit. **Table 5-6** summarizes the cancer and non-cancer risks for the future use scenario at the Chattanooga Creek Tar Deposit. The calculations may be found in Appendix C.

Table 5-5
Summary of Cancer and Noncancer Risks by Exposure Route
Current Use Scenario
Chattanooga Creek Tar Deposit
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor	
		Cancer	HI
Chattanooga Creek Tar Deposit (1)	Inadvertent Ingestion Soil	8E-07	0.01
	Dermal Contact Soil	1E-06	0.004
	Inhalation dust	7E-09	NA
	TOTAL RISK	**2E-06**	**0.01**

(1) Chattanooga Creek Tar Deposit surface soil (SS) samples: SS-45 through SS-62

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not Applicable

Table 5-6
Summary of Cancer and Noncancer Risks by Exposure Route
Future Use Scenario
Chattanooga Creek Tar Deposit
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor		Site Worker	
		Cancer	HI	Cancer	HI
Chattanooga Creek Tar Deposit (1)	Inadvertent Ingestion Soil	8E-07	0.01	1E-05	0.03
	Dermal Contact Soil	1E-06	0.004	7E-06	0.01
	Inhalation dust	7E-09	NA	2E-07	NA
	Ingestion Groundwater *	NA	NA	NA	NA
	Inhalation VOCs while Showering *	NA	NA	NA	NA
	TOTAL RISK	**2E-06**	**0.01**	**2E-05**	**0.04**

(1) Chattanooga Creek Tar Deposit surface soil (SS) samples: SS-45 through SS-62
Groundwater samples: MW-13 and MW-16-SH

* No chemicals of potential concern were identified in groundwater near the Chattanooga Creek tar deposit.

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not Applicable

The total incremental lifetime cancer risk estimate for a site worker is 2×10^{-5}. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI less than one. Note that the future risk for a site visitor is the same as the current risk.

5.4 CHATTANOOGA CREEK SEDIMENTS AND GROUNDWATER

The Chattanooga Creek Sediments are considered accesible to child and adult residents who were assumed to visit Chattanooga Creek 4 times/month for 3 months/year (summer months), or 12 visits/year. Current and future use of this area are considered the same.

Exposure routes examined in this risk assessment are:

- inadvertent ingestion of sediment
- dermal contact with sediment

The risks associated with exposure to sediment in Chattanooga Creek are summarized in **Table 5-7**; spreadsheets showing the calculations are presented in Appendix D. Since exposure to surface water is not examined, in can be assumed that the calculated risk would be higher if the water were shown to be similarly impacted, though the magnitude of the risk cannot be quantified at this time.

5.4.1 UPPER REACH RISK SUMMARY

The sum of risks associated with currently complete exposure routes ranges from 5×10^{-7} for an adult resident to 1×10^{-6} for the lifetime resident. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on HIs less than one.

Table 5-7
Summary of Cancer and Noncancer Risks by Exposure Route
Current Use Scenario
Chattanooga Creek Sediments
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Child Resident		Adult Resident		Lifetime Resident	
		Cancer	HI	Cancer	HI	Cancer	HI
Upper Reach (1)	Inadvertent Ingestion	4E-07	0.02	3E-07	0.005	7E-07	0.01
	Dermal Contact	1E-07	0.004	3E-07	0.002	4E-07	0.003
	TOTAL RISK	**5E-07**	**0.03**	**6E-07**	**0.01**	**1E-06**	**0.01**
Middle Reach (2)	Inadvertent Ingestion	3E-04	0.3	3E-04	0.1	6E-04	0.1
	Dermal Contact	3E-04	0.2	5E-04	0.1	7E-04	0.1
	TOTAL RISK	**6E-04**	**0.5**	**8E-04**	**0.2**	**1E-03**	**0.2**
Lower Reach (3)	Inadvertent Ingestion	1E-06	0.01	1E-06	0.01	3E-06	0.02
	Dermal Contact	1E-06	0.01	2E-06	0.01	3E-06	0.01
	TOTAL RISK	**3E-06**	**0.03**	**4E-06**	**0.02**	**6E-06**	**0.03**

(1) The Upper reach is the area from Burnt Mill Bridge to the railroad bridge between Hooker and Hamill Roads.
(2) The Middle reach is the area between the railroad bridge (between Hooker and Hamill Roads) and Dobbs Branch.
(3) The Lower reach is the area between Dobbs Branch and the Tennessee River.

HI: Hazard Index (noncancer risk)
NA Not Applicable

5.4.2 MIDDLE REACH RISK SUMMARY

The sum of risks associated with currently complete exposure routes ranges from 6×10^{-4} for an adult resident to 1×10^{-3} for the lifetime resident. This estimate is above EPA's target range for Superfund sites. Non-cancer effects are not expected based on HIs less than one.

5.4.3 LOWER REACH RISK SUMMARY

The sum of risks associated with currently complete exposure routes ranges from 3×10^{-6} for an adult resident to 6×10^{-6} for the lifetime resident. This estimate is within EPA's target range for Superfund sites. Non-cancer effects are not expected based on HIs less than one.

5.4.4 GROUNDWATER NEAR CHATTANOOGA CREEK

Monitor wells MW-14-SH and MW-15-SH were constructed near the Middle Reach of Chattanooga Creek. The contaminants in these wells were screened and residential exposure assumptions were applied to assess the hypothetical risk. The results of these calculations are presented in **Table 5-8**. The lifetime excess cancer risk is 4×10^{-5} which is within EPA's target range for Superfund sites. Non-cancer effects would be possible based on HIs greater than one.

5.5 RESIDENTIAL AREAS / SCHOOL YARD

Several surface soil samples were collected from residential areas and a school yard. A list of sample locations is provided in **Appendix L**. Each of these locations was evaluated separately. Current and future use of these properties was considered the same.

5.5.1 CURRENT USE RISK SUMMARY

Exposure routes potentially complete are:

Table 5-8
Summary of Cancer and Noncancer Risks by Exposure Route
Future Use Scenario
Groundwater near Chattanooga Creek
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Child Resident		Adult Resident		Lifetime Resident	
		Cancer	HI	Cancer	HI	Cancer	HI
Groundwater near Chattanooga Creek	Ingestion Groundwater	1E-05	9	2E-05	4	3E-05	5
	Inhalation VOCs while Showering	NA	NA	1E-05	4	1E-05	4
	TOTAL RISK	**1E-05**	**9**	**3E-05**	**8**	**4E-05**	**9**

Groundwater samples: MW-14 and MW-15-SH

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not Applicable

- inadvertent ingestion of soil
- dermal contact with soil
- inhalation of dust

Table 5-9 summarizes the cancer and non-cancer risks for residents. The calculations may be found in Appendix E. The total incremental lifetime cancer risk estimates range from 2×10^{-5} to 1×10^{-4}. These estimates are within EPA's target range for Superfund sites. Non-cancer effects are possible for child receptors at each of the locations based on HIs equal to or greater than one. Non-cancer effects are not expected for adult or lifetime residents based on HIs less than one.

5.6 NORTHEAST TRIBUTARY AREA

The Northeast Tributary Area is accessible to a site visitor. In the future, it may be redeveloped as commmercial/idustrial property.

5.6.1 CURRENT USE RISK SUMMARY

Exposure routes potentially complete are:

- inadvertent ingestion of soil
- dermal contact with soil
- inhalation of dust.
- inadvertent ingestion of surface water from the Northeast Tributary
- dermal contact with surface water from the Northeast Tributary
- inadvertent ingestion of sediment from the Northeast Tributary
- dermal contact with sediment from the Northeast Tributary

Table 5-10 summarizes the cancer and non-cancer risks for a site visitor at the Northeast Tributary Area. The calculations may be found in Appendices F, G, and K. The total

Table 5-9
Summary of Cancer and Noncancer Risks by Exposure Route
Current Use Scenario
Residential Areas
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure	Child Resident		Adult Resident		Lifetime Resident	
		Cancer	HI	Cancer	HI	Cancer	HI
Resident 65	Inadvertent Ingestion	4E-05	2	2E-05	0.2	5E-05	0.6
	Dermal Contact	8E-06	0.2	1E-05	0.1	2E-05	0.1
	Inhalation	2E-07	0.1	2E-07	0.03	3E-07	0.03
	TOTAL RISK	**5E-05**	**2**	**3E-05**	**0.4**	**8E-05**	**0.8**
Resident 66	Inadvertent Ingestion	2E-05	0.9	9E-06	0.1	3E-05	0.3
	Dermal Contact	3E-06	0.1	6E-06	0.1	9E-06	0.1
	Inhalation	1E-08	NA	1E-08	NA	2E-08	NA
	TOTAL RISK	**2E-05**	**1**	**1E-05**	**0.1**	**4E-05**	**0.3**
Resident 67	Inadvertent Ingestion	3E-05	2	1E-05	0.2	4E-05	0.5
	Dermal Contact	7E-06	0.2	1E-05	0.1	2E-05	0.1
	Inhalation	8E-09	0.1	1E-08	0.03	2E-08	0.03
	TOTAL RISK	**4E-05**	**2**	**3E-05**	**0.3**	**6E-05**	**0.7**
Resident 68	Inadvertent Ingestion	2E-05	2	8E-06	0.2	3E-05	0.5
	Dermal Contact	3E-06	0.2	6E-06	0.1	9E-06	0.1
	Inhalation	9E-09	0.1	1E-08	0.02	2E-08	0.02
	TOTAL RISK	**2E-05**	**2**	**1E-05**	**0.3**	**4E-05**	**0.6**
Resident 69	Inadvertent Ingestion	2E-05	1	1E-05	0.2	3E-05	0.4
	Dermal Contact	4E-06	0.1	8E-06	0.1	1E-05	0.1
	Inhalation	1E-08	0.04	1E-08	0.01	2E-08	0.01
	TOTAL RISK	**3E-05**	**2**	**2E-05**	**0.2**	**5E-05**	**0.5**
Resident 70	Inadvertent Ingestion	3E-05	1	1E-05	0.1	4E-05	0.4
	Dermal Contact	5E-06	0.1	1E-05	0.1	1E-05	0.1
	Inhalation	1E-08	0.1	1E-08	0.02	3E-08	0.02
	TOTAL RISK	**3E-05**	**2**	**2E-05**	**0.2**	**5E-05**	**0.5**
Resident 71	Inadvertent Ingestion	1E-05	0.9	6E-06	0.1	2E-05	0.3
	Dermal Contact	1E-06	0.1	3E-06	0.04	4E-06	0.1
	Inhalation	8E-09	0.04	9E-09	0.01	2E-08	0.01
	TOTAL RISK	**2E-05**	**1**	**9E-06**	**0.1**	**2E-05**	**0.3**
Resident 72	Inadvertent Ingestion	3E-05	2	1E-05	0.3	4E-05	0.7
	Dermal Contact	3E-06	0.3	6E-06	0.1	1E-05	0.2
	Inhalation	1E-08	0.1	2E-08	0.04	3E-08	0.04
	TOTAL RISK	**3E-05**	**3**	**2E-05**	**0.4**	**5E-05**	**0.9**
Resident 73	Inadvertent Ingestion	4E-05	2	2E-05	0.2	5E-05	0.6
	Dermal Contact	9E-06	0.2	2E-05	0.1	2E-05	0.1
	Inhalation	1E-08	0.1	1E-08	0.03	2E-08	0.03
	TOTAL RISK	**4E-05**	**2**	**3E-05**	**0.3**	**8E-05**	**0.7**
Resident 75	Inadvertent Ingestion	6E-05	0.2	3E-05	0.03	8E-05	0.1
	Dermal Contact	2E-05	0.02	4E-05	0.01	6E-05	0.01
	Inhalation	6E-09	0.01	6E-09	0.002	1E-08	0.002
	TOTAL RISK	**8E-05**	**0.3**	**7E-05**	**0.04**	**1E-04**	**0.1**
Resident 77	Inadvertent Ingestion	3E-05	1	1E-05	0.1	5E-05	0.4
	Dermal Contact	7E-06	0.1	1E-05	0.1	2E-05	0.1
	Inhalation	1E-08	0.1	1E-08	0.01	3E-08	0.01
	TOTAL RISK	**4E-05**	**1**	**3E-05**	**0.2**	**7E-05**	**0.5**

Cancer: Excess cancer risk level
HI: Hazard index (non-cancer risk)
NA: not applicable

Table 5-10
Summary of Cancer and Noncancer Risks by Exposure Route
Current Use Scenario
Northeast Tributary Area
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor	
		Cancer	HI
Adjacent to Northeast Tributary	Inadvertent Ingestion Soil	1E-04	0.03
	Dermal Contact Soil	2E-04	0.04
	Inhalation Dust	2E-08	0.000001
	Inadvertent Ingestion Surface Water	2E-06	0.1
	Dermal Contact Surface Water	5E-04	0.5
	Inadvertent Ingestion Sediment	4E-05	0.1
	Dermal Contact Sediment	7E-05	0.03
	TOTAL RISK	**9E-04**	**0.7**

Surface soil samples: NET-01 through NET-10
Surface water (SW) samples: SW-12 through SW-17, SW-23 through SW-27
Sediment (SD) samples: SD-12 through SD-17 and SD-23

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not Applicable

Northwest Tributary surface water samples: SW-6 through SW-10
Northwest Tributary (NW) sediment samples: SW-6 and SD-9

incremental lifetime cancer risk estimate is 3×10^{-4}. This estimate is above EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI of less than one.

5.6.2 FUTURE USE RISK SUMMARY

In the future, this area may be developed as commercial/industrial property . **Table 5-11** summarizes the cancer and non-cancer risks for the future use scenario at the Northeast Tributary. The calculations may be found in Appendices F, G, and K. The total incremental lifetime cancer risk estimate for a site worker is 3×10^{-3}. This estimate is above EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI less than one. Note that the future risk for a site visitor is the same as the current risk.

5.7 NORTHWEST TRIBUTARY AREA

The Northwest Tributary Area is accessible to a site visitor. Future use is expected to remain the same.

5.7.1 CURRENT AND FUTURE USE RISK SUMMARY

Exposure routes potentially complete are:

- inadvertent ingestion of surface water from the Northwest Tributary
- dermal contact with surface water from the Northwest Tributary
- inadvertent ingestion of sediment from the Northwest Tributary
- dermal contact with sediment from the Northwest Tributary

Table 5-12 summarizes the cancer and non-cancer risks for a site visitor at the Northwest Tributary Area. The calculations may be found in Appendices F and G. The total incremental lifetime cancer risk estimate is 8×10^{-7}. This estimate is below EPA's target range for Superfund sites. Non-cancer effects are not expected based on an HI of less than one.

Table 5-11
Summary of Cancer and Noncancer Risks by Exposure Route
Future Use Scenario
Northeast Tributary Area
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor		Site Worker	
		Cancer	HI	Cancer	HI
Adjacent to Northeast Tributary	Inadvertent Ingestion Soil	1E-04	0.03	2E-03	0.2
	Dermal Contact Soil	2E-04	0.04	1E-03	0.1
	Inhalation Dust	2E-08	0.000001	6E-07	0.00002
	Inadvertent Ingestion Surface Water	2E-06	0.1	NA	NA
	Dermal Contact Surface Water	5E-04	0.5	NA	NA
	Inadvertent Ingestion Sediment	4E-05	0.1	NA	NA
	Dermal Contact Sediment	7E-05	0.03	NA	NA
	TOTAL RISK	**9E-04**	**0.7**	**3E-03**	**0.4**

Surface soil samples: NET-01 through NET-10
Surface water (SW) samples: SW-12 through SW-17, SW-23 through SW-27
Sediment (SD) samples: SD-12 through SD-17 and SD-23

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not applicable

Table 5-12
Summary of Cancer and Noncancer Risks by Exposure Route
Current and Future Use Scenarios
Northwest Tributary Area
Tennessee Products Site
Chattanooga, Tennessee

Location	Exposure Route	Site Visitor	
		Cancer	HI
Northwest Tributary	Inadvertent Ingestion Surface Water	2E-10	0.003
	Dermal Contact Surface Water	4E-10	0.001
	Inadvertent Ingestion Sediment	4E-07	0.1
	Dermal Contact Sediment	3E-07	0.04
	TOTAL RISK	**8E-07**	**0.1**

Northwest Tributary surface water samples: SW-6 through SW-10
Northwest Tributary sediment samples: SW-6 and SD-9

Cancer: Excess cancer risk level
HI: Hazard Index (noncancer risk)
NA: Not applicable

6.0 SUMMARY

A baseline risk assessment was conducted for the Tennessee Products Site. Data used in this evaluation were obtained from the "Chattanooga Creek Sediment Profile Study" conducted by EPA between April and August 1992 (EPA, 1992a); the investigation conducted for the Mead Corp. (ERM, 1995); and the RI field investigation performed for EPA by CDM Federal in 1995 (CDM Federal, 1996).

The data were segregated into seven groups: the Coke Plant Area, the Schwerman Trucking Site, the Chattanooga Creek Tar Deposit, the Chattanooga Creek Sediments and Groundwater, the Residential Areas / School Yard, the surface water and sediment in tributaries to Chattanooga Creek (Northeast and Northwest Tributaries). The data were evaluated and COPCs were identified for each of these groups.

The exposure assessment concluded that current receptors may include site visitors and area residents. Future receptors may include on-site workers and residents. Potentially complete exposure pathways examined in this risk assessment are:

- ingestion of soil,
- dermal contact with soil,
- ingestion of surface water (other than Chattanooga Creek),
- dermal contact with surface water (other than Chattanooga Creek),
- ingestion of sediment (on-site and in Chattanooga Creek),
- dermal contact with sediment (on-site and in Chattanooga Creek),
- ingestion of groundwater,
- inhalation of volatile organic compounds (VOCs) released from groundwater, and
- inhalation of dust.

EPA's reference toxicity values were obtained for each of the COPCs. These values were combined with estimates of human intake to characterize the cancer and noncancer risks associated with the site.

EPA's acceptable target range for carcinogenic risk at Superfund sites is 1×10^{-4} to 1×10^{-6}. The assessment concluded that the total incremental lifetime cancer risk is above EPA's acceptable target range for the following locations:

- Coke Plant Area (future use),
- Schwerman Trucking Site (future use),
- Chattanooga Creek Sediments and Groundwater (current and future use), and
- Northeast Tributary Area (current and future use).

Non-cancer effects, as measured by HIs greater than one, are possible at the following:

- Coke Plant Area (future use),
- Schwerman Trucking Site (future use),
- Chattanooga Creek Sediments and Groundwater (future use), and
- Residential Areas / School Yard (current and future use).

The assessment concluded that the total incremental lifetime cancer risk is within or below EPA's acceptable target range for the following:

- Coke Plant Area (current use),
- Schwerman Trucking Site (current use),
- Chattanooga Creek Tar Deposit (current and future use), and
- Residential Areas / School Yard (current and future use).
- Northwest Tributary Area (current and future use).

Non-cancer effects, as measured by HIs less than one, are not expected at the following:

- Chattanooga Creek Tar Deposit (current and future use), and
- Northwest Tributary Area (current and future use).

7.0 REMEDIATION GOAL OPTIONS

Risk-based remediation goal options (RGOs) provide remedial design staff with long-term targets to use during analysis and selection of remedial alternatives. Ideally, such goals, if achieved, should both comply with applicable, relevant, or appropriate requirements (ARARs) and result in residual risks that fully satisfy the NCP (EPA, 1985) requirements for the protection of human health and the environment. Risk-based RGOs are guidelines and do not establish that cleanup to meet these goals is warranted.

Risk-based RGOs are calculated for chemicals of concern (COCs) only. COCs are the most significant contaminants in an exposure scenario that exceeds an excess cancer risk level of 1×10^{-4} or an HI of 1 (e.g., Coke Plant, on-site worker scenario). More specifically, COCs have individual excess cancer risk levels of 1×10^{-6} or an HQ of 0.1 in a given exposure scenario. COPCs that exceed a state or federal ARAR are also COCs. COPCs that fail to satisfy one or more of these criteria are excluded.

RGOs are calculated by combining the intake levels of each COC by a receptor from all appropriate exposure routes for a particular medium within a use scenario and rearranging the site-specific risk equations to solve for the concentration term (RGO). RGOs are calculated separately for cancer and non-cancer effects. RGOs for carcinogens correspond to incremental cancer risk levels of 1×10^{-4}, 1×10^{-5}, and 1×10^{-6}. RGOs for non-carcinogens correspond to HQs of 0.1, 1, and 3.

It should be understood that COCs, and the corresponding RGOs, are not only site-specific, but also receptor-specific. This explains the multiple iterations of COCs and RGOs for individual source areas. To simplify the presentation, RGOs for residential scenarios are a combination of RGOs for lifetime residents and children. For carcinogens, RGOs are based on lifetime exposure assumptions and for non-carcinogens, RGOs are based on exposure to children. This combination results in the lowest (most conservative) set of RGOs for the three possible receptors (children, adults, lifetime residents),

and avoids the necessity of selecting one of the three as the basis for cleanup goals. The following tables present the COCs and the corresponding RGOs for each applicable area/receptor combination:

- **Table 7-1**, Coke Plant Area, RGOs for surface soil, on-site worker scenario,
- **Table 7-2**, Coke Plant Area, RGOs for groundwater, on-site worker scenario,
- **Table 7-3,** Coke Plant Area, RGOs for groundwater, residential scenario,
- **Table 7-4**, Schwerman Trucking Site, RGOs for groundwater, on-site worker scenario,
- **Table 7-5**, Schwerman Trucking Site, RGOs for groundwater, residential scenario,
- **Table 7-6**, Chattanooga Creek - Middle Reach, RGOs for sediment, residential scenario,
- **Table 7-7**, Groundwater near Chattanooga Creek, RGOs for groundwater, residential scenario,
- **Table 7-8**, Residential Areas / School Yard, RGOs for soil, residential scenario,
- **Table 7-9**, Northeast Tributary Area, RGOs for soil, visitor scenario, and
- **Table 7-10**, Northeast Tributary Area, RGOs for soil, on-site worker scenario.

Spreadsheets showing the RGO calculations are presented in **Appendix J.**

Table 7-1
Summary of Risk-Based Remediation Goal Options for Surface Soil
Coke Plant Area
On-site Worker Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (mg/kg)		Cancer Risk Level (mg/kg)			Hazard Quotient Level (mg/kg)		
	Min	Max	1E-6	1E-5	1E-4	HQ = 0.1	HQ = 1	HQ = 3
Arsenic	4.5	98	3	32	318	51	512	1,536
Benzo(a)anthracene	0.076	780	4	44	437	NA	NA	NA
Chrysene	0.13	750	437	4,374	43,744	NA	NA	NA
Benzo(b &/or k)fluoranthene	0.11	1,100	4	44	437	NA	NA	NA
Benzo(a)pyrene	0.04	540	0.4	4	44	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.17	210	4	44	437	NA	NA	NA
Dibenzo(a,h)anthracene	0.06	76	0.4	4	44	NA	NA	NA

Min / Max: Minimum / maximum detected concentration
HQ: Hazard quotient (non-cancer risk)
NA: Not applicable

Table 7-2
Summary of Risk-Based Remediation Goal Options and ARARs for Groundwater
Coke Plant Area
On-site Worker Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (ug/l)		Cancer Risk Level (ug/l)			Hazard Quotient Level (ug/l)			MCLs (ug/l)
	Min	Max	1E-6	1E-5	1E-4	HQ=0.1	HQ=1	HQ=3	EPA
Arsenic	5	30	0.2	2	19	3	31	92	50
Barium	29	3,800	NA	NA	NA	715	7,154	21,462	2,000
Beryllium	1	7	NA	NA	NA	20	204	613	4
Lead	3	33	NA	NA	NA	NA	NA	NA	15 (AL)
Manganese	18	77,000	NA	NA	NA	235	2,351	7,052	NA
Iron	100	160,000	NA	NA	NA	3,066	30,660	91,980	NA
Cyanide	10	860	NA	NA	NA	51	511	1,533	200
1,4-Dichlorobenzene	1	110	12	119	1,192	NA	NA	NA	75
Naphthalene	2	6,100	NA	NA	NA	409	4,088	12,264	NA
Bis(2-ethylhexyl)phthalate	500	500	20	204	2,044	204	2,044	6,132	6
Benzo(a)anthracene	120	120	0.4	4	39	NA	NA	NA	NA
Chrysene	98	98	39	392	3,920	NA	NA	NA	NA
Benzo(b &/or k)fluoranthene	1	110	0.4	4	39	NA	NA	NA	NA
Benzo(a)pyrene	10	82	0.04	0.4	4	NA	NA	NA	0.2
Indeno(1,2,3-cd)pyrene	10	49	0.4	4	39	NA	NA	NA	NA
Carbazole	2	330	14	143	1,431	NA	NA	NA	NA
Alpha-BHC	0.01	7	0.05	0.5	5	NA	NA	NA	NA
Beta-BHC	0.01	5	0.2	2	16	NA	NA	NA	NA
Chloroform	2	540	47	469	4,691	102	1,022	3,066	100 *
1,2-Dichloroethane	220	220	3	31	314	NA	NA	NA	5
Carbon tetrachloride	620	620	2	22	220	7	72	215	5
Trichloroethene	53	53	26	260	2,601	61	613	1,840	5
Benzene	1	2,600	10	99	987	NA	NA	NA	5
Tetrachloroethene	1	10,000	6	55	550	102	1,022	3,066	5
Toluene	2	170,000	NA	NA	NA	2,044	20,440	61,320	1000
Chlorobenzene	2	1,100	NA	NA	NA	204	2,044	6,132	100

Min / Max: Minimum / maximum detected concentration
NA: Not applicable
HQ: Hazard quotient (noncancer risk)
MCLs: U.S. EPA Maximum Contaminant Levels
* Total trihalomethanes
AL: Action Level

Table 7-3
Summary of Risk-Based Remediation Goal Options and ARARs for Groundwater
Coke Plant Area
Resident Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (ug/l)		Cancer Risk Level (ug/l)			Hazard Quotient Level (ug/l)			MCLs (ug/l)
	Min	Max	1E-6	1E-5	1E-4	HQ=0.1	HQ=1	HQ=3	EPA
Arsenic	5	30	0.04	0.4	4	0.5	5	14	50
Barium	29	3,800	NA	NA	NA	110	1,095	3,285	2,000
Beryllium	1	7	NA	NA	NA	3	31	94	4
Lead	3	33	NA	NA	NA	1	8	23	15 (AL)
Aluminum	50	47,000	NA	NA	NA	94	939	2,816	NA
Manganese	18	77,000	NA	NA	NA	8	78	235	NA
Iron	100	160,000	NA	NA	NA	63	626	1,877	NA
Cyanide	10	860	NA	NA	NA	31	313	939	200
1,4-Dichlorobenzene	1	110	NA	NA	NA	NA	NA	NA	75
Naphthalene	2	6,100	NA	NA	NA	1	6	19	NA
Phenanthrene	2	490	NA	NA	NA	0.5	5	14	NA
Bis(2-ethylhexyl)phthalate	500	500	NA	NA	NA	1,564	15,643	46,929	6
Benzo(a)anthracene	120	120	NA	NA	NA	36	360	1,079	NA
Chrysene	98	98	NA	NA	NA	469	4,693	14,079	NA
Benzo(b &/or k)fluoranthene	1	110	NA	NA	NA	0.1	1	4	NA
Benzo(a)pyrene	10	82	NA	NA	NA	11	110	329	0.2
Indeno(1,2,3-cd)pyrene	10	49	NA	NA	NA	469	4,693	14,079	NA
2,4-Dimethylphenol	10	2,000	NA	NA	NA	8	78	235	NA
2-Methylnaphthalene	2	1,100	NA	NA	NA	139	1,392	4,177	NA
Dibenzofuran	2	250	2.8	28	279	NA	NA	NA	NA
2-Methylphenol	2	1,100	NA	NA	NA	141	1,408	4,224	NA
(3- &/or 4-)Methylphenol	10	2,000	NA	NA	NA	63	626	1,877	NA
Carbazole	2	330	NA	NA	NA	47	469	1,408	NA
Alpha-BHC	0.01	7	NA	NA	NA	94	939	2,816	NA
Beta-BHC	0.01	5	NA	NA	NA	63	626	1,877	NA
Delta-BHC	0.02	3	NA	NA	NA	47	469	1,408	NA
Chloroform	2	540	NA	NA	NA	469	4,693	14,079	100 *
1,2-Dichloroethane	220	220	NA	NA	NA	63	626	1,877	5
1,1,1-Trichloroethane	92	92	NA	NA	NA	47	469	1,408	200
Carbon tetrachloride	620	620	4.8	48	478	31	313	939	5
Trichloroethene	53	53	0.09	0.9	9	NA	NA	NA	5
Benzene	1	2,600	9.2	92	917	NA	NA	NA	5
Tetrachloroethene	1	10,000	0.09	0.9	9	NA	NA	NA	5
Toluene	2	170,000	0.01	0.1	1	NA	NA	NA	1000
Chlorobenzene	2	1,100	0.09	0.9	9	NA	NA	NA	100
Ethylbenzene	3	320	0.01	0.1	1	NA	NA	NA	700
Acetone	83	1,700	NA	NA	NA	47	469	1,408	NA
3-Nitroaniline	25	25	NA	NA	NA	939	9,386	28,157	NA

MCLs: U.S. EPA Maximum Contaminant Levels
AL: Action Level
* Total trihalomethanes
Min / Max: Minimum / maximum detected concentration
NA: Not applicable
HQ: Hazard quotient (noncancer risk)
Note: Cancer risk levels based on lifetime exposure assumptions; risk levels for non-carcinogens based on exposure to children.

Table 7-4
Summary of Risk-Based Remediation Goal Options and ARARs for Groundwater
Schwerman Trucking Site
On-site Worker Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (ug/l)		Cancer Risk Level (ug/l)			Hazard Quotient Level (ug/l)			MCLs (ug/l)
	Min	Max	1E-6	1E-5	1E-4	HQ=0.1	HQ=1	HQ=3	EPA
Arsenic	9	30	0.2	2	19	3	31	92	50
Beryllium	4	4	NA	NA	NA	20	204	613	4
Cadmium	1	14	NA	NA	NA	5	51	153	5
Nickel	5	47,000	NA	NA	NA	204	2,044	6,132	100
Aluminum	51	38,000	NA	NA	NA	10,220	102,200	306,600	NA
Manganese	320	15,000	NA	NA	NA	235	2,351	7,052	NA
Iron	8,800	460,000	NA	NA	NA	3,066	30,660	91,980	NA
Acetone	2,200	2,200	NA	NA	NA	1,022	10,220	30,660	NA

Min / Max: Minimum / maximum detected concentration
NA: Not applicable
HQ: Hazard quotient (noncancer risk)
MCLs: U.S. EPA Maximum Contaminant Levels
* Total trihalomethanes
AL: Action Level

Table 7-5
Summary of Risk-Based Remediation Goal Options and ARARs for Groundwater
Schwerman Trucking Site
Resident Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (ug/l)		Cancer Risk Level (ug/l)			Hazard Quotient Level (ug/l)			MCLs (ug/l)
	Min	Max	1E-6	1E-5	1E-4	HQ=0.1	HQ=1	HQ=3	EPA
Arsenic	9	30	0.04	0.4	4	0.5	5	14	50
Beryllium	95	160	NA	NA	NA	3	31	94	4
Cadmium	1	14	NA	NA	NA	1	8	23	5
Chromium	3	23	NA	NA	NA	8	78	235	100
Nickel	5	47,000	NA	NA	NA	31	313	939	100
Aluminum	51	38,000	NA	NA	NA	1,564	15,643	46,929	NA
Manganese	320	15,000	NA	NA	NA	36	360	1,079	NA
Iron	8,800	460,000	NA	NA	NA	469	4,693	14,079	NA
Methyl ethyl ketone	1,800	1,800	NA	NA	NA	939	9,386	28,157	NA
Methyl isobutyl ketone	290	290	NA	NA	NA	125	1,251	3,754	NA
Acetone	2,200	2,200	NA	NA	NA	156	1,564	4,693	NA

MCLs: U.S. EPA Maximum Contaminant Levels
AL: Action Level
* Total trihalomethanes
Min / Max: Minimum / maximum detected concentration
NA: Not applicable
HQ: Hazard quotient (noncancer risk)
Note: Cancer risk levels based on lifetime exposure assumptions; risk levels for non-carcinogens based on exposure to children.

Table 7-6
Summary of Risk-Based Remediation Goal Options for Sediment
Chattanooga Creek Sediments-Middle Reach
Resident Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (mg/kg)		Cancer Risk Level (mg/kg)			Hazard Quotient Level (mg/kg)		
	Min	Max	1E-6	1E-5	1E-4	HQ = 0.1	HQ = 1	HQ = 3
Benzo(a)anthracene	0.07	2,700	1	6	61	NA	NA	NA
Chrysene	0.07	2,400	61	608	6,083	NA	NA	NA
Benzo(b &/or k)fluoranthene	0.11	4,200	1	6	61	NA	NA	NA
Benzo(a)pyrene	0.05	2,100	0.1	1	6	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0.04	1,900	0.6	6	61	NA	NA	NA
Dibenzo(a,h)anthracene	0.05	410	0.1	1	6	NA	NA	NA
Dibenzofuran	0.04	1,900	NA	NA	NA	1,024	10,241	30,724
Alpha-BHC	0.01	51	0.1	1	7	NA	NA	NA
Dieldrin	0.1	7	0.0	0.3	3	13	128	384
PCB-1248	12	12	0.1	1	6	NA	NA	NA

Remediation goals based on ingestion and dermal contact exposure.
Min / Max: Minimum / maximum detected concentration
HQ: Hazard quotient (non-cancer risk)
Note: Cancer risk levels based on lifetime exposure; non-carcinogens based on childhood exposure only.

Table 7-7
Summary of Risk-Based Remediation Goal Options and ARARs for Groundwater
Groundwater near Chattanooga Creek
Resident Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (ug/l)		Cancer Risk Level (ug/l)			Hazard Quotient Level (ug/l)			MCLs (ug/l)
	Min	Max	1E-6	1E-5	1E-4	HQ=0.1	HQ=1	HQ=3	EPA
Iron	32,000	36,000	NA	NA	NA	469	4,693	14,079	NA
Alpha-BHC	0.1	0.1	0.01	0.1	1	NA	NA	NA	NA
Beta-BHC	0.1	0.1	0.04	0.4	4	NA	NA	NA	NA
Gamma-BHC (Lindane)	0.02	0.02	0.05	0.5	5	0.5	5	14	0.2
Delta-BHC	0.03	0.03	0.05	0.5	5	0.5	5	14	NA
Dieldrin	0.02	0.02	0.004	0.04	0.4	0.1	1	2	NA
Benzene	54	54	1	12	115	NA	NA	NA	5
Chlorobenzene	520	810	NA	NA	NA	31	313	939	100

MCLs: U.S. EPA Maximum Contaminant Levels
Min / Max: Minimum / maximum detected concentration
NA: Not applicable
HQ: Hazard quotient (noncancer risk)
Note: Cancer risk levels based on lifetime exposure assumptions; risk levels for non-carcinogens based on exposure to children.

Table 7-8
Summary of Risk-Based Remediation Goal Options for Surface Soil
Residential Areas / School Yard
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (mg/kg)		Cancer Risk Level (mg/kg)			Hazard Quotient Level (mg/kg)		
	Min	Max	1E-6	1E-5	1E-4	HQ = 0.1	HQ = 1	HQ = 3
Arsenic	3.2	15	0.4	4	36	2	21	64
Chromium	4	55	178	1,779	17,785	36	356	1,069
Aluminum	2,100	32,000	NA	NA	NA	7,125	71,250	213,749
Manganese	130	2,800	NA	NA	NA	151	1,513	4,538
Benzo(a)anthracene	0.13	6.1	1	8	81	NA	NA	NA
Chrysene	0.11	5.8	81	813	8,127	NA	NA	NA
Benzo(b &/or k)fluoranthene	0.26	9	1	8	81	NA	NA	NA
Benzo(a)pyrene	0.15	5	0.1	1	8	NA	NA	NA
Dieldrin	0.0028	1.8	0.04	0.4	4	0.3	3	8

Min / Max: Minimum / maximum detected concentration
HQ: Hazard quotient (non-cancer risk)
NA: Not applicable
Note: Cancer risk levels based on lifetime exposure; non-carcinogens based on childhood exposure only.

Table 7-9
Summary of Risk-Based Remediation Goal Options for Surface Soil
Northeast Tributary Area
Site Visitor Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (mg/kg)		Cancer Risk Level (mg/kg)			Hazard Quotient Level (mg/kg)		
	Min	Max	1E-6	1E-5	1E-4	HQ = 0.1	HQ = 1	HQ = 3
Benzo(a)anthracene	24	840	48	482	4,818	NA	NA	NA
Chrysene	24	840	4,818	48,181	481,806	NA	NA	NA
Benzo(b &/or k)fluoranthene	45	1,800	48	482	4,818	NA	NA	NA
Benzo(a)pyrene	25	1,000	5	48	482	NA	NA	NA
Indeno(1,2,3-cd)pyrene	15	470	48	482	4,818	NA	NA	NA
Dibenzo(a,h)anthracene	96	96	5	48	482	NA	NA	NA

Min / Max: Minimum / maximum detected concentration
HQ: Hazard quotient (non-cancer risk)
NA: Not applicable

Table 7-10
Summary of Risk-Based Remediation Goal Options for Surface Soil
Northeast Tributary Area
On-site Worker Scenario
Tennessee Products Site
Chattanooga, Tennessee

Chemicals of Concern	Detections (mg/kg)		Cancer Risk Level (mg/kg)			Hazard Quotient Level (mg/kg)		
	Min	Max	1E-6	1E-5	1E-4	HQ = 0.1	HQ = 1	HQ = 3
Arsenic	3	29	3	32	318	51	512	1,536
Benzo(a)anthracene	24	840	4	44	437	NA	NA	NA
Chrysene	24	840	437	4,374	43,744	NA	NA	NA
Benzo(b &/or k)fluoranthene	45	1,800	4	44	437	NA	NA	NA
Benzo(a)pyrene	25	1,000	0.4	4	44	NA	NA	NA
Indeno(1,2,3-cd)pyrene	15	470	4	44	437	NA	NA	NA
Dibenzo(a,h)anthracene	96	96	0.4	4	44	NA	NA	NA
Alpha-BHC	0.4	5	1	5	51	NA	NA	NA

Min / Max: Minimum / maximum detected concentration
HQ: Hazard quotient (non-cancer risk)
NA: Not applicable

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